DEVELOPMENT OF TECHNIQUE FOR TESTING THE LONG-TERM STABILITY OF SILICON MICROSTRIP DETECTORS

A.V. Kosinov, N. I. Maslov, S. V. Naumov, V. D. Ovchinnik, A. F. Starodubtsev, G. P. Vasilyev, V. I. Yalovenko, L. Bosisio[1]
NSC KIPT, Kharkov, Ukraine
[1]Istituto Nazionale di Fisica Nucleare, Sezione di Trieste, Trieste, Italy
E-mail: nikolai.maslov@kipt.kharkov.ua

An automatic multi-channel set-up prototype for simultaneous testing of the Long-Term Stability (LTS)* of more than ten detectors is described. The Inner Tracking System of the ALICE experiment will include about two thousand Double-Sided Microstrip Detectors (DSMD). Efficient automatic measurement techniques are crucial for the LTS test, because the corresponding test procedure should be performed on each detector and requires long times, at least two days. By using special adapters for supporting and connecting the bare DSMDs, failing detectors can be screened out before module assembly, thus minimizing the cost. Automated probe stations developed for a special purpose or for microelectronics industry are used for measuring physical static DSMD characteristics and check good-to-bad element ratio for DSMD. However, automated (or semi-automatic) test benches for studying LTS or testing DSMD long-term stability before developing a detecting module are absent.

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1. INTRODUCTION

Long-term stability of detector characteristics is a subject of study by several collaborations who are using microstrip detectors in their experimental apparatuses [1-3]. The Inner Tracking System of the ALICE experiment will include about two thousand Double-Sided Microstrip Detectors (DSMD) which are required to work reliably for a long time (order of ten years), with very limited access for repairs or replacements in case of component failure [4]. During their operation many factors, like: micro break-downs of the p/n junctions making up each of the thousands of detecting elements, charge build-up at the Si-SiO_2 interface, degradation of guard rings, drift of ionic charges at the detector surface, etc. could change the parameters of the DSMD [1]. As a consequence, an important part of the detector test and quality assurance procedure must consist of the verification and systematic study of the long-term stability of the basic characteristics of the sensors (leakage currents, inter-electrode impedance), including an investigation of the effect of such environmental conditions as humidity levels or temperatures differing from those foreseen during normal operation inside the ALICE apparatus.

Automated probe stations developed for a special purpose [5] or for microelectronics industry [6] are used for measuring physical static DSMD characteristics and check good-to-bad element ratio for DSMD. However, automated (or semi-automatic) test benches for studying LTS or testing DSMD long-term stability before developing a detecting module are absent.

2. AUTOMATIC MULTI-CHANNEL SET-UP

The set-up prototype consists of the following elements: bias-voltage supply unit, switching unit (switch card), current-measuring device, input-output device, temperature sensor, humidity sensor, light-tight box, and computer with special software installed (Fig.1).

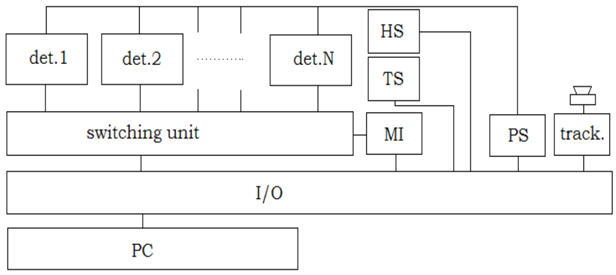

Fig.1. Automatic bench for studying long-term stability of microstrip detectors, where: det.1-det.N are the detectors being monitored, TS is the temperature sensor, MI is the measuring instrument, PS is the (bias) voltage supply unit, I/O is the input-output register

The detectors under test are placed inside the light-tight box together with the temperature and humidity sensors. The supply unit, the temperature and humidity probes and the switch card are connected to the computer via the input-output register. As a temperature probe a specialized microchip is employed, connected via the input-output register. The bench is supplied with a system which monitors the operation of the computer and sends an alarm in case of malfunctioning (Fig.1, tracker system). This helps preventing losses of test results.

3. SOFTWARE OF THE AUTOMATIC SET-UP

The computer software can control the voltage output from the supply unit, which is fed in parallel to the elements of the microstrip and/or single-element detectors. The computer ramps up or down the bias voltage in steps before and after the LTS test. It is possible to measure the total leakage currents of the microstrip detectors, the leakage currents of guard rings, the leakage currents of a few strips, and the leakage currents of the single-element detectors in the range from 10 pA to 1 mA. At regular time intervals during the test, the computer writes in a file the values of the parameters measured for each detector, together with the time stamp and the temperature/humidity values. Fig.2 shows the control system screen before measurements.

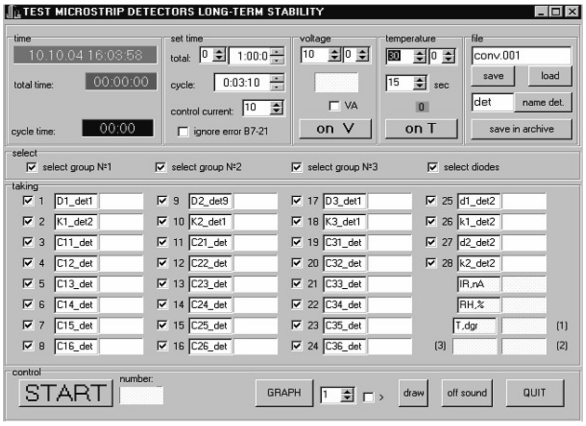

Fig.2. The control system screen before measurements

During measurement, parameters can be presented in numerical or graphical mode.

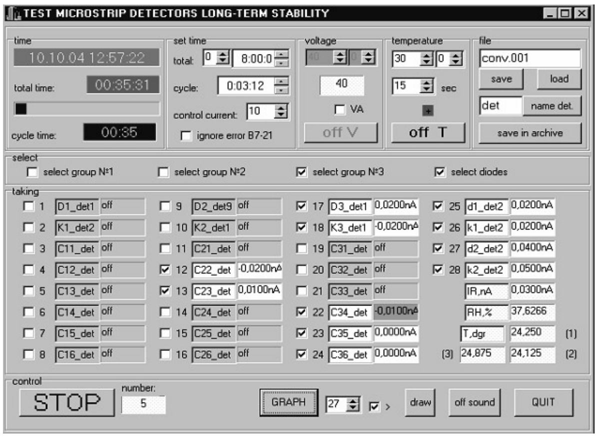

Fig.3. The control system screen during measurements in numerical mode

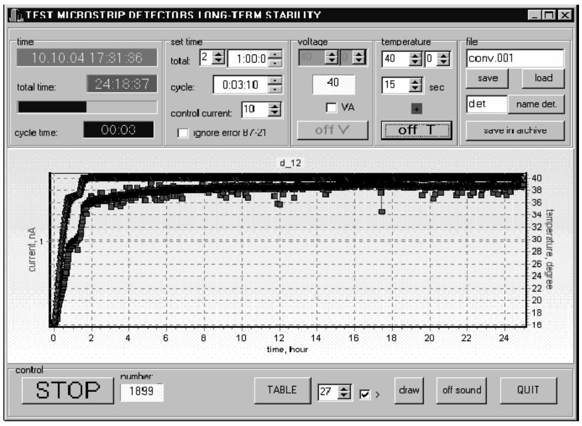

Fig.4. The control system screen during measurements in graphical mode

4. PROCEDURE OF LONG-TERM STABILITY TEST

The foreseen procedure for the LTS test consists in the periodic repetition of the leakage current measurement of the different electrodes of the detectors during a long time period. The detectors are placed in a dark box, mounted on custom made adapters that will include special micropositioners for the electrical contacts to detectors. The switch card will perform and manage the connections between the various detectors under test, the power supply and the measuring instruments. The computer controls the power supply and the switch card, and reads out the data from the *I/V*-meter and the temperature/humidity sensors using specially developed software. The switch card allows us to measure the leakage currents of the bias line, the guard ring and a sample strip for each of the detectors under test, using a single *I*-meter. The voltage is continuously applied to the detectors for the whole duration of the test (typically 48 hours or more).

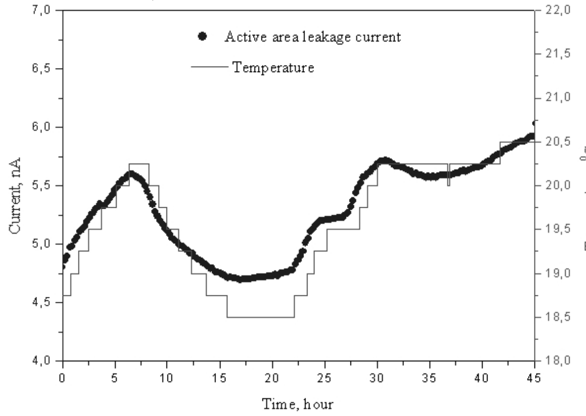

Fig.5. Leakage current of the detector active area and temperature variation versus time. Planar detector with the active area of S_{AA}=5×5 mm

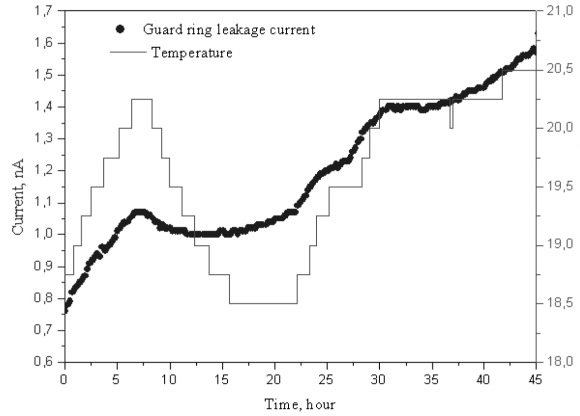

Fig.6. Leakage current of the detector guard ring and temperature variation versus time. Planar detector with the active area of S_{AA}=5×5 mm

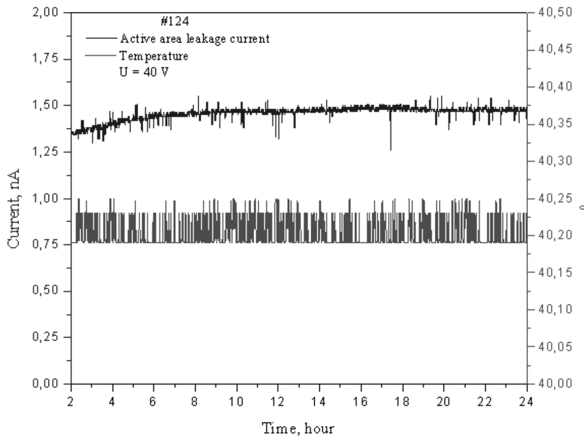

Fig.7. Leakage current of the detector active area (above) and temperature variation (below) versus time. Regime of temperature stabilization

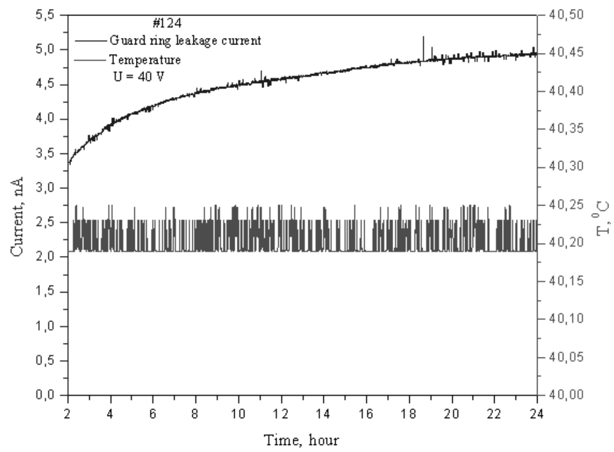

Fig.8. Leakage current of the detector guard ring and temperature variation versus time. Regime of temperature stabilization

In order to allow an investigation of the physical processes leading to instabilities in the detector parameters, the system provides the possibility to measure the current-voltage characteristics of detectors both before and after the LTS test.

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УСОВЕРШЕНСТВОВАНИЕ МЕТОДИКИ ТЕСТИРОВАНИЯ ДОЛГОВРЕМЕННОЙ СТАБИЛЬНОСТИ КРЕМНИЕВЫХ МИКРОСТРИПОВЫХ ДЕТЕКТОРОВ

А.В. Косинов, Н.И. Маслов, С.В. Наумов, В.Д. Овчинник, А.Ф. Стародубцев, Г.П Васильев, В.И. Яловенко, Л.Босисио

Важная часть тестирования детектора и процедура определения гарантии качества состоит в изучении долговременной стабильности основных характеристик (ДСХ) детекторов, включая исследование эффектов влияния окружающей среды, таких как влажность или температура. В данной работе описаны метод тестирования и автоматический многоканальный стенд, специально разработанный для одновременного тестирования ДСХ более чем десяти детекторов.

Эта работа поддержана частично INTAS, проект № 03-55-964.

УДОСКОНАЛЕННЯ МЕТОДИКИ ТЕСТУВАННЯ ДОВГОСТРОКОВОЇ СТАБІЛЬНОСТІ КРЕМНІЄВИХ МІКРОСТРИПОВЫХ ДЕТЕКТОРІВ

А.В. Косінов, М.І. Маслов, С.В. Наумов, В.Д. Овчінник, А.Ф. Стародубцев, Г.П Васільєв, В.І. Яловенко, Л.Босісіо

Важлива частина тестування детектора і процедури визначення гарантії якості складається у вивченні довгострокової стабільності основних характеристик (ДСХ) детекторів, включаючи дослідження ефектів впливу навколишнього середовища, таких як вологість або температура. У даній роботі описані метод тестування та автоматичний стенд, спеціально розроблений для одночасного тестування ДСХ більш ніж десяти детекторів.

Ця робота підтримана частково INTAS, проект № 03-55-964.