Quality assurance of CBM-STS silicon micro-strip sensors using pulsed infra-read laser*

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The Silicon tracking system (STS) of the CBM experiment is aimed to reconstruct the trajectories of the hundreds of charged particles created in heavy-ion collision, and to determine their momenta with a resolution of around $\Delta p/p \approx 1\%$. This precision is prerequisite for high-resolution mass measurements of e.g. rare probes and implies a thin detection system, with high-resolution space-point measurement and capable of interaction rates up to 10 MHz. The STS will comprise 1220 silicon microstrip sensors from which 896 detector modules will be constructed [1]. Quality assurance of the sensors is an important pre-requisite for the detector module production as the assembly steps are non-reworkable to a good extend. These tests can be either invasive or non-invasive as explained below. From the results entered into a database, one can identify sensors or detector modules with certain characteristics and grade them according to their performance.

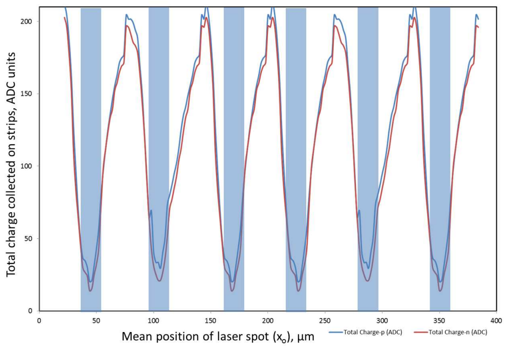
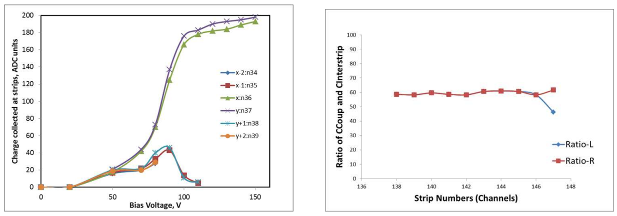


Figure 1: Amplitude response of a few strips from a detector module scanned with a laser spot.

Invasive methods are the characterization with methods that require physical contact of probes to the objects. The important features are: (i) this allows detailed analyses of the device under test (DUT), (ii) this leaves scratches or marks on the surface, (iii) this is limited to sensors, not to detector modules, (iv) this method involves passive electrical measurements using a wafer prober and micro-probing needles [2].

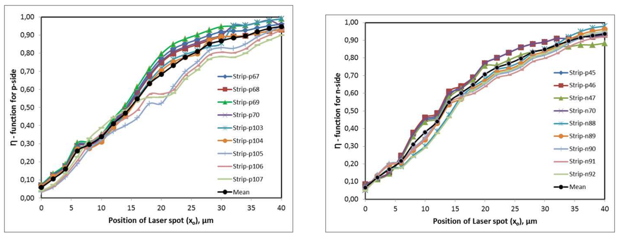
Non-invasive methods are the characterization with methods that do not require physical contact of probes. The important features are: (i) a few significant parameters of the DUT can be investigated, (ii) this leaves no scratches or marks on the surface, (iii) this is not limited to bare sensors but can be applied to detector modules, (iv) this method involves injection of localized charge using a pulsed infra-red laser [3].

The laser test stand (LTS) is developed with the idea to perform key quality assurance tests on silicon detector modules. The significant parameters that can be analysed or investigated using the LTS are: (i) Uniformity of charge collection (or strip integrity) from scanning the strips. An example of such laser scan is shown in Fig. 1. (ii) Operation voltage from the bias scan. An example of charge collection as function of the bias voltage is shown in Fig. 2 (a). (iii) Charge coupling to neighbour and next-neighbour strips from bias scan. An example is shown in Fig. 2 (a). (iv) Ratio of AC-coupling to inter-strip capacitance from amplitude response at specific positions. An example is shown in Fig. 2 (b). (v) Charge sharing function (η) in the inter-strip region can be determined. Figure 3 shows η-function dependence with the position of the laser spot.



(a) (b)

Figure 2: a) Operating voltage determination and charge sharing between neighbouring and next to neighbouring strips and b) Ratio of coupling to inter-capacitance.



(a) (b)

Figure 3: Charge sharing measurements in the inter-strip region of a silicon detector module: a) p-side and b) n-side.

References

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[2] P. Ghosh, PoS (Bormio 2013) 018, 2013
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