Development of low-mass readout cables for the CBM Silicon Tracking System

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Low-mass readout cables are of critical importance in the Silicon Tracking System (STS) under development for the CBM experiment. The aperture of the tracking stations is planned to be kept free of readout electronics that is arranged at the perimeter of the fiducial area instead. The signals from the double-sided silicon microstrip detectors are routed through multi-line fine-pitch cables to those readout boards, bridging distances of up to around 50 cm. Prototype cables are being developed in cooperation with SE SRTIIE of the State Space Agency of Ukraine [1].

The cable is based on microline-structured aluminum layers on polyimide carrier foils. Line pitches down to a few tens of micrometers are feasible depending on the length of the cable to be realized. The electrical connection of the lines to both the detectors and the readout electronics are laid out as tab bonds through openings in the polyimide foil.

Demonstrators of a fine-structured single-layer cable tab-bonded to prototype microstrip detectors CBM02 were realized in the year 2008. The aluminum signal lines are 14 μm thick, 20 μm wide and have 50 μm pitch at the detector. The objects were used in the recent STS beam test [2]. Further optimized specimen, shown in Fig. 1, were produced in 2010 to complete a reference tracking system for forthcoming in-beam tests of STS components.

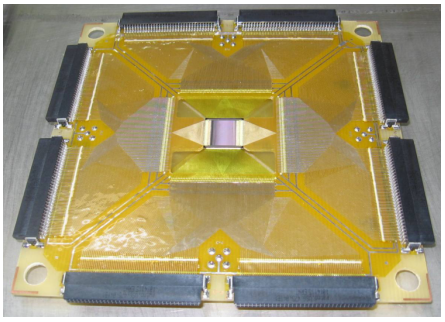

Figure 1: Demonstrator board 2b-4 with a CBM02 detector

High line densities up to 50 μm pitch can only be produced in short cables. From about 7 cm length on, the signal paths must be arranged staggered across two signal layers at e.g. double line pitch. Demonstrators of such multi-layer cables were produced already last year [3]. In the first approach, they yielded non-symmetric capacitive load to the readout electronics. This is shown in Fig. 2, obtained with the simulation package RAPHAEL of Synopsis TCAD. An improved cable design is shown in Fig. 3. It is being used in the demonstrator module shown in Fig. 4 with three daisy-chained microstrip detectors and a multi-layer readout cable of 1024 signal lines. Measurements of the line capacitances yield close values for the upper and lower layer, about 0.3 pF per cm. The material budget of the cable is between 0.1% and 0.17% radiation length.

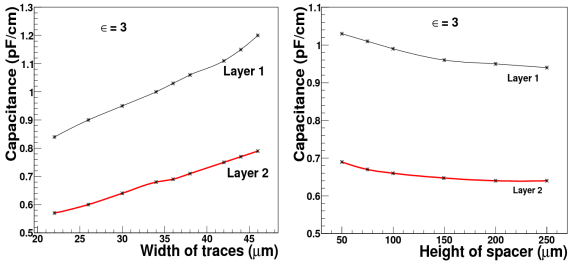

Figure 2: Line capacitance in the upper and lower signal layers as a function of the width of the traces (left) and the thickness of the spacer (right)

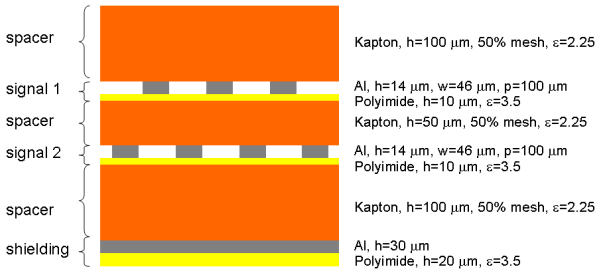

Figure 3: Cross section of the readout cable

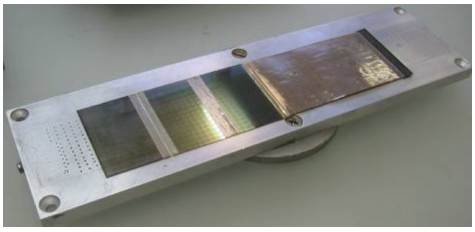

Figure 4: Demonstrator 2a with ISTC03/CBM03 detectors

Further electrical parameters, e.g. the line resistivity as a source of noise, are being addressed together with the designers of the front-end electronics. Also the radiation hardness of the polyimide material is being studied [4].

References

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[3] V. M. Borshchov *et al.*, *CBM Progress Report 2009*, Darmstadt 2010, p. 15

[4] D. Severin *et al.*, *Radiation hardness of low-mass readout cables for the CBM experiment*, this report