Signal transmission in low-mass readout cables for the CBM Silicon Tracking System *

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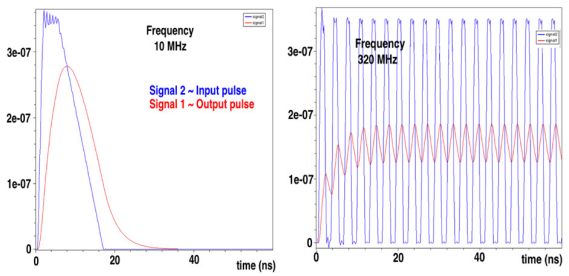
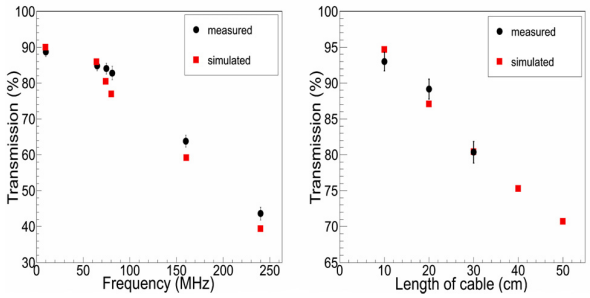
Readout cables will bridge the distance between the microstrip sensors and the electronics placed at the periphery of the tracking stations. Since the length of cables can reach up to 50 cm for the inner modules, it is very important to extract the expected transmission losses in the cables as this will be reflected in the signal/noise ratio. Mixed-mode simulations have been done to assess transmission loss in cables. The mixed-mode capability of Sentaurus Device (subpackage of SYNOPSYS) [1] allows for the simulation of a circuit that combines any number of Sentaurus devices of arbitrary dimensionality (1D, 2D, or 3D) with other devices based on compact models (SPICE).
To study the impact of input pulse frequency, square pulses are injected through the sensor and the output pulse is seen at the end of the cable. Figure 1 shows the impact of input pulse frequency on the output pulse. For higher frequencies, the signal amplitude decreases and the pulse broadens at the input of the front end electronics which may lead to charge loss depending on the RC time constant of the readout chip shaper. The decrease in signal amplitude may lead to lower threshold which could result in more noise again depending on the RC time constant of the integrator. Secondly, the pulse broadening may lead to the charge loss if we use fast electronics, i.e. a short shaping time of the preamplifier. One can notice pile up effect at higher frequencies. Pile-up effect is when the second pulse arrives relatively early and rides on the falling tail of the first pulse. Also a baseline shift can be observed for higher frequency pulse output. For example, in Figure 1(b) the baseline shift is around 18% of the input pulse amplitue (0.6×10^{-7}). In our calculations, baseline corrections have been taken into account.



(a) (b)

Figure 1: Dependence of transmission losses on input pulse period using mixed-mode simulation: (a) 100 ns, (b) 3.13 ns.

For validation of the transmission (dB) loss determined using mixed-mode simulations, dB loss in a CBM prototype cable with aluminum traces has been measured using a Vector Network Analyser [2]. Figure 2(a) shows the comparison of measured values with simulations up to 240 MHz. The simulated data match with measurements withing 5% error thus validating the simulation approach. In simulations, continuous attenuation with frequency can be seen since the readout cable acts as a low pass filter. Figure 2(b) shows the dependence of transmission loss on the length of the cables. Simulation and measurements match well. A mathematical model for the dependence of transmission loss on the length of cables has been extracted.
The transmission losses increase with frequency and length of the cable. Also for the frequency range of interest for the present prototype front-end chip in the fast shaper mode (25 MHz), the transmission is expected to be around 85% for a 30 cm long cable.



(a) (b)

Figure 2: (a) Comparison of measured transmission coefficient with simulations for a CBM prototype readout cable of length 30 cm; (b) dependence of transmission loss on the length of cables.

References

[1] http://www.synopsys.com/home.aspx.

[2] http://www2.rohde-schwarz.com/product/ZVA.html Vector Network Analyzer. 10Hz/9KHz...4GHz . ZVRE

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