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IR Transparent Silicon Microstrip Detectors optimized for tracker alignment

The next experiments at particle colliders will demand stability of the tracking systems to the level of few microns. The available technology can not provide a supporting structure able to guarantee this degree of stability in working condition, when environmental changes will misalign the detectors out of their nominal position. Looking at the AMS and then the CMS experiences, a straight laser beam that sequentially traverses consecutive layers of silicon microstrips detectors, can be used as an artificial track to align them. For such a laser track to reach the last sensor, high transmittance of microstrips to infrared (IR) light is needed. With the idea of integrating this alignment concept in the standard production process of the detectors, we have simulated the passage of a coherent beam of light through a microstrips detector and identified the minimum set of changes to the design and technology that boost its transmittance while still respecting their tracking capabilities. The first prototypes have been fabricated at CNM-IMB clean room facilities. Then we performed electric and optical characterization of the samples in the CNM and IFCA laboratories. In this talk we are going to present experimental results in comparison with simulation predictions.

Summary (Additional text describing your work. Can be pasted here or give an URL to a PDF document):

A Laser Alignment System is an elegant solution to monitor the stability of a Tracker with a minimum impact on system integration and no need of extra material budget.
In a nutshell consecutive layers of silicon sensor are traversed by IR laser beams which play the role of infinite momentum tracks, not bent by magnetic field.
Silicon is almost transparent to IR light. Still, its absorption is enough to produce a measurable signal which can be read with the sensors DAQ electronic to reconstruct the track. The higher transmittance of the detectors, the more sensors can be aligned with a single beam and then the simpler the system becomes.
In a microstrips detector geometrical and technological characteristics are of interest to its optical performance. We have simulated [1] the passage of a coherent beam of light through a microstrips detector tuning the thicknesses of the different material layers involved in its process fabrication and the pitch/strip-width ratio to optimize transmittance without affecting the detection behaviour. We design the mask for the first prototypes respecting simulation hints (metal strip/pitch width <10%) and adding test structures to validate simulation results. All the structures have 256 readout channels with a pitch of 50 µm and have been modified opening a ˜ 1 cm diameter hole in the Al backplane to let the laser beam pass through them. Six of the twelve detectors have been completed with intermediate floating strips without metal, in order to improve the spatial resolution. Then we have produced the detectors in the CNM-IMB [2] clean room facilities appropriately changing the standard process to achieve the thickness value of every material layer optimized by simulations. We take special care in the thickness of passivation layers (SiO2 and Si2N3) as they could play the role of built-in antireflection coating. The finished structures have been optically and electrically characterized in the CNM and IFCA [3] laboratories using the ALIBAVA [4] readout system (up to 256 channels, SNR= 20 in no irradiated detectors). The first experimental results are going to be presented in this talk.

1 "Infrared-transparents microstrip detectors"M.Fernández et al. Nuclear Instruments and Methods in Physics Reserch A (2008), Pages 84-85.
2 http://www.cnm.es/
3 http://www.ifca.unican.es/
4"A Portable Readout System for Microstrip Silicon Sensors (ALIBAVA)"Marco-Hernandez, Ricardo; Nuclear Science Symposium Conference Record, 2008. NSS '08. IEEE 19-25 Oct. 2008 Page(s):3201 - 3208

Primary author: BASSIGNANA, Daniela (IMB-CNM CSIC)

Co-authors: VIRTO, Amparo (IFCA); MUÑOZ, Francisca (IFCA); PELLEGRINI, Giulio (IMB-CNM CSIC); VILA, Iván (IFCA); LOZANO, Manuel (IMB-CNM CSIC); FERNANDEZ, Marcos (IFCA); JARAMILLO, Richard (IFCA)

Presenter: BASSIGNANA, Daniela (IMB-CNM CSIC)