IR Transparent microstrip detector for a laser alignment system for future silicon trackers at ILC

D. Bassignana[1], M. Fernández[2], M. Lozano[1], G. Pellegrini[1], I. Vila [2]

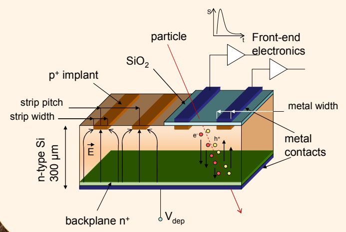
1 Centro Nacional de Microelectrónica IMB-CNM-CSIC, Campus Universidad Autónoma Barcelona, 08193 Bellaterra, Barcelona (Spain);
2 Instituto de Física de Cantabria (IFCA), Ed. Juan Jorda, E-39005 Santander (Spain)

Introduction

The next generation of tracking systems, as the one envisaged for the International Linear Collider (ILC), demand track momentum resolutions one order of magnitude better than current state-of-the-art trackers. Mechanical stabilities coping with the precision of such measurements should either be provided by the construction of the supporting structure (currently out of the technological reach) or monitored using an alignment system. The SiLC (Silicon for Linear Collider) collaboration proposed to use a Laser Alignment System.
We propose an R&D on microstrip detectors for the tracker in order to obtain high spatial resolution and maxim transmittance to the IR beam.
Optical and electric simulation have been carried out and a new mask for prototypes fabrication has been designed.

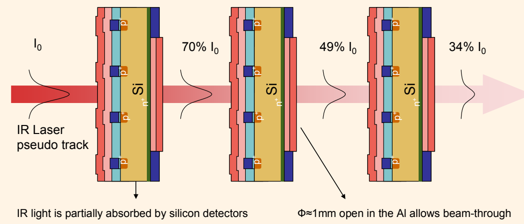
Microstrip detectors

Basic scheme and working principle



Laser Alignment System

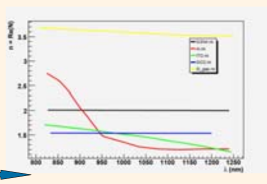
In a nutshell, consecutive layers of silicon sensors are traversed by IR laser beams which play the role of infinite momentum tracks, not bent by the magnetic field. Then, the same sophisticated alignment algorithms employed for track alignment with real particles can be applied to achieve relative alignment between modules to better precision than a few microns. Furthermore, since IR light produces a measurable signal in the silicon bulk, there is no need for any extra readout electronics.

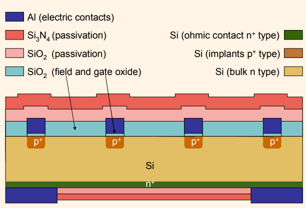


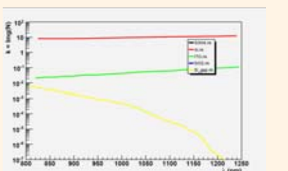
Optical simulation

N= n-ik

Part of the laser light is absorbed by the detector.
Optical simulations[1] of the prototype have been done to study the **transmittance**, **absorptance** and **reflectance** of light at infrared wavelengths. Refraction effects have been taken into account.

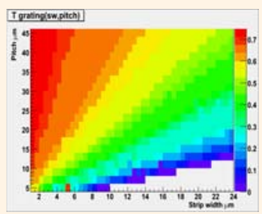






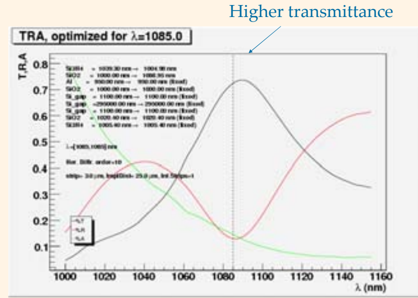
The idea is to tune the thicknesses of the different material layers and the pitch/strip-width ratio of the sensors to optimize transmittance without affecting the electric characteristics .

- pitch 50 μm (fixed)
- gate oxide 36.5 nm (fixed)



!!! Metal-strip Width !!!

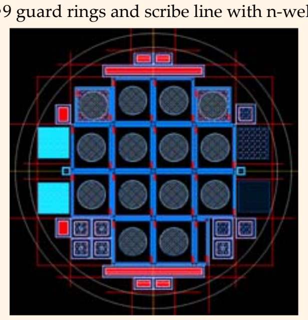
Higher transmittance

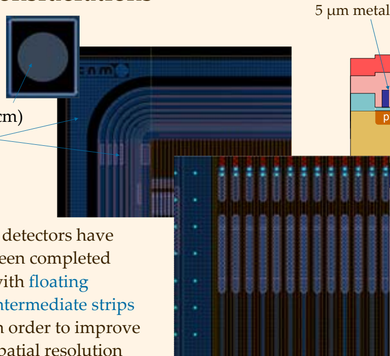


Simulations have been carried out with the use of RODIS and CAMFR software, which implement the RCWA and an Eigenmode Expansion respectively to solve Maxwell equations.

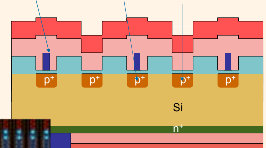
Mask design and electric considerations

12 different detectors
Common parameters:
- Active area= 1.2x1.5 cm^2
- 256 readout strips with 1.5 cm length
- Circular window in the back metal (r=0.5 cm)
- 9 guard rings and scribe line with n-well



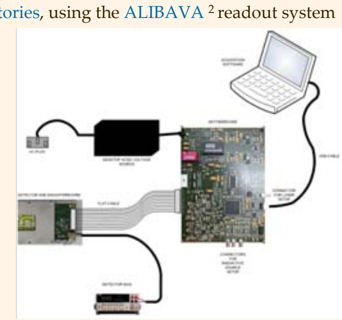


6 detectors have been completed with floating intermediate strips in order to improve spatial resolution using the capacitive charge division principle.



	p+ strip width	Metal width	Intermediate strips
1	15um	15um	1
2	15um	10um	1
3	15um	5um	1
4	15um	3um	1
5	12.5um	5um	1
6	17.5um	5um	1
7	15um	15um	no
8	15um	10um	no
9	15um	5um	no
10	15um	3um	no
11	12.5um	5um	no
12	17.5um	5um	no

The detectors will be processed in the IMB-CNM clean room facilities and then characterized in the CNM Radiation Laboratory and in the IFCA laboratories, using the ALIBAVA [2] readout system



- Up to 256 readout channels
- SNR≈20 in no irradiated detectors

Conclusions

- Optical simulations have been done on a microstrip detector model. The results obtained suggest that to reach a transmittance ≥ 70% a pitch/metal-strip-width ratio ≤0.10 is required, while the thicknesses of the layers are related to each other. The best combination has been chosen to obtain the maximum transmittance.
- The mask for the first prototypes of transparent detectors has been designed, including all the test structures useful to investigate the topics highlighted by the simulation work
- The detectors will be processed in the IMB-CNM clean room facilities and their characterization will be performed using the ALIBAVA readout system.

1 "Infrared-transparents microstrip detectors" M.Fernández et al. *Nuclear Instruments and Methods in Physics Reserch A* (2008), Pages 84-85.
2 "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