ABSTRACT SUBMITTED TO THE VIC-10 CONFERENCE

TITLE :

Towards a 10 μs, thin high resolution pixelated CMOS sensor system for future vertex detectors

Corresponding author : R. De Masi[1],
on behalf of the IPHC-IRFU-IKF collaboration

J.Baudot, G.Bertolone, A.Brogna, G.Claus, C.Colledani, A.Dorokhov, G.Doziére, W.Dulinski, M.Goffe, J.C.Fontaine, Ch.Hu-Guo, A.Himmi, K.Jaaskelainen, M.Koziel, F.Morel, C.Santos, M.Specht, I.Valin, G.Voutsinas, M.Winter
IPHC, IN2P3/CNRS, 23 rue du Loess, 67037 Strasbourg Cedex 2, France

Y. Degerli, M.Gelin, F.Orsini
IRFU / SEDI, CEA Saclay, 91191 Gif-sur-Yvette Cedex, France

M.Deveaux
IFK, Goethe-Universitt, Max von Laue-Strasse 1, 60438 Frankfurt/Main, Germany

http://www.iphc.cnrs.fr/-CMOS-ILC-.html

Abstract :

CMOS pixel sensors of the MIMOSA series are being developed since several years for reconstructing displaced vertices, precisely enough to identify charmed hadrons by measuring the displacement of their decay vertex. This problematic is particularly present in future heavy ion collision programmes: MIMOSA sensors are going to equip the upgraded vertex detector of the STAR experiment at RHIC and are being developed for the micro-vertex detector of the CBM experiment at FAIR. Since recently they are also being considered as an option for the upgrade of the ALICE inner tracker. The identification of heavy hadrons through the determination of their displaced decay vertex is also crucial for the physics program envisaged at the ILC, for example, in the study of the Higgs boson's properties, since in the Standard Model the Higgs is expected to decay mostly in heavy quarks and bosons.

The development of MIMOSA sensors has recently led to an architecture addressing these requirements. It was developed in the framework of the EUDET project, supported by the EU (FP6), whose goal is to provide an infrastructure for the detector R&D for the ILC. The first full scale CMOS sensor based on this architecture, called MIMOSA-26, was fabricated in 2009. Made of 665,000 pixels (18 μm pitch) covering an active area of $\sim$2 cm^2, it delivers zero-suppressed binary signals, which allow running at $\sim$10 kframes/s. It was tested in the laboratory and with minimum ionising particles at the CERN-SPS. The sensor presently equips the reference planes of the EUDET beam telescope and it constitutes the forerunner for the evolution towards the applications to the above mentioned experiments. **The contribution to the conference will overview the main features of this pioneering sensor including laboratory and beam test results. It will then discuss the evolutions of its architecture, especially towards higher readout frequencies.**

[1]e-mail: Rita.DeMasi@IReS.in2p3.fr

The topic of radiation tolerance will then be addressed, which is an issue for certain applications envisaged, like the CBM vertex detector. While CMOS manufacturing processes proposed up to recently were based on low resistivity epitaxial layers, a new processing technology has become available, featuring a high resistivity epitaxial layer, which allows depleting the sensitive volume. A prototyping chip has been fabricated with 0.6 μm feature size to explore the capability of the technology to improve the sensor non-ionising radiation tolerance. The chip has been tested on a high energy beam at the CERN-SPS. **The talk will describe beam test results showing that improvements of about 2 orders of magnitude in radiation tolerance are achievable.**

Another advantage of sensors with depleted sensitive volume is the increase of the charge collection efficiency. This allows to increase the size of the pixel pitch without reducing the detection efficiency, which translates into shorter readout times for the sensor architecture featured by MIMOSA-26. In 2009, a collaboration has been founded whose goal is the realization of a light double-sided ladder equipped with MIMOSA-26 sensors, in order to study system integration aspects relevant for a vertex detector at the ILC. Highly granular sensors could then be mounted on one side of the ladder and depleted sensors with rectangular pixels on the other side. By correlating the pixels hit on both faces of the ladder by a traversing particle, a timestamp can be attributed to the particle track.

The talk will expose how this structure is expected to provide a detector which combines high spatial resolution (few microns) with a time resolution of about 10 μs, a target value for the ILC and CBM applications.