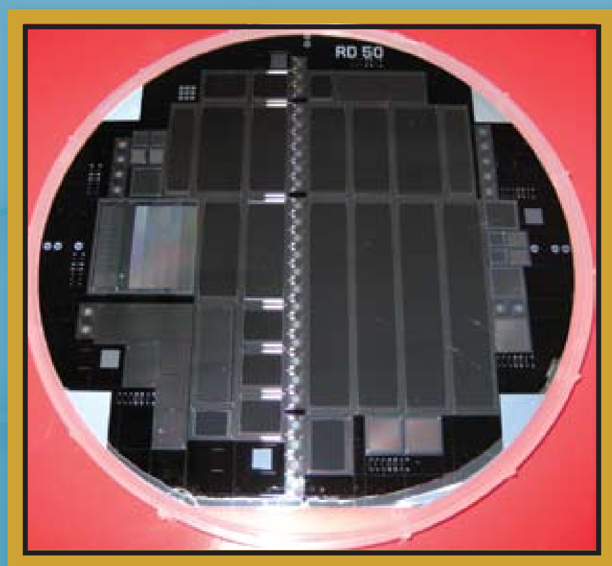
Advanced Instrumentation Seminars

January 9, 2008
1:30 pm, 1st Floor
KAVLI Auditorium

Development of Radiation Hard Tracking Detectors



Guest Speaker –
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The Large Hadron Collider (LHC) at CERN has been designed to achieve the unprecedented luminosity of 10^{34} cm^{-2}s^{-1}. Recently, a 10-fold luminosity upgrade has been proposed (SuperLHC). To exploit the physics potential of the upgraded LHC, an efficient tracking down to a few centimeters from the interaction point will be required, where fast hadron fluences above 10^{16} cm^{-2} will be accumulated after more than 5 years operation (3000 fb-1). Present vertex detectors, relying on highly segmented silicon sensors, are designed to survive fast hadron fluences of about 10^{15} cm^{-2}. Semiconductor detectors seem the best option for vertex sensors in the next generation of colliders as well, provided that their radiation hardness is significantly improved.

The CERN RD50 collaboration "Development of Radiation Hard Semiconductor Devices for Very High Luminosity Colliders" was founded in 2002 with the aim to develop a new reliable detector technology for the LHC upgrade or a future high luminosity hadron collider. Three main research lines have been identified: the understanding of the microscopic defects causing the degradation of the irradiated detectors, material engineering, with the aim of producing semiconductor material with increased radiation-hardness (SiC, GaN, Czochralski and epitaxial silicon, oxygen enriched Float Zone silicon), and device engineering, i.e. variations in the sensor geometry, to develop a more radiation tolerant detector geometry.

The main radiation damage phenomena to semiconductor detectors are: the increase of the leakage current with the irradiation fluence due to the creation of generation-recombination centers, the change in the effective doping concentration at heavy fluences leading to increased depletion voltage and possibly involving the inversion of the space charge sign, a shortening of the carrier lifetimes due to increased trapping at radiation-induced defects, responsible for a loss of charge and the detoriation of the surface condition influencing inter-strip isolation and interstrip capacitance. All of these influence the parameters of the detectors and have to be taken into account in the selection of tracking detectors in high particle fluxes.

The present plans for the ATLAS Upgrade are taken as an example how the work on radiation hardness is being applied.

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