Study to upgrade the silicon tracker of the Belle II experiment

The Belle II experiment, located near Tokyo in Japan, is a large international particle physics experiment, which aims to discover physics process beyond the Standard Model (SM) of particle physics. The existence of such new phenomena is highly motivated by shortcomings of the the Standard Model itself. Belle II is situated at the SuperKEKB asymmetric electron-positron collider facility, which will produce collisions at an unprecedented instantaneous luminosity of 8×10^{35} $cm^{-2}.s^{-1}$. This intensity is forty times larger than the current world record of any other particle collider, including the LHC at CERN. Over the course of the next decade Belle II aims to record a unique data set of over 50 billion $e^+e^- \rightarrow b\bar{b}$, $c\bar{c}$, $\tau^+\tau^-$ processes. These huge samples offers an excellent sensitivity to new quantum phenomena that may arise in decays of the produced b or c-quarks and τ-leptons, which are short-lived particles.

A key feature of the Belle II experiment is the vertex detector (VXD). The VXD being composed of silicon sensors with high granularity, tracks and their origin (vertex) can be reconstructed with high precision. However, the very high luminosity provided by SuperKEKB comes along with parasitic particles or beam-induced backgrounds. These backgrounds generate radiations shortening the operating life of sensors. Additionally, they also dominate the sensor occupancy, which decreases the performances of track reconstruction algorithms. Consequently, an upgrade of the current VXD technology is considered for the late years of the Belle II experiment to alleviate these two major problems: radiation-tolerance and track-reconstruction at very high occupancy.

The Belle II group in Strasbourg proposes to build a complete VXD with the powerful technology of CMOS pixel sensors in order to outperform the existing detector. During the internship, the student will evaluate performances for tracking and vertexing of various new geometries for the VXD on simulated Belle II data. The study will aim to identify the critical design parameters of both the sensors and the geometry to actually improve the current situation.

This work has natural extension toward impacts of the VXD upgrade on various key physics channels. These additional research would be the subject of a potential PhD thesis.

For references, consult:
o the Belle II experiment web page: https://www.belle2.org
o the IPHC Belle II group web page: http://www.iphc.cnrs.fr/Belle2

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