Search for physics beyond the Standard Model with e+e- collisions, and development of a new concept of internal trajectometer

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The highest priority of the experimental particle physics community is to discover signs of physics processes beyond the Standard Model. One ongoing approach consists in exploring the energy frontier at the LHC with hadron collisions. Another powerful and complementary way relies on the study of e+e- collisions. Such a system allows to access new quantum properties of particles, benefiting from the relatively simple final states resulting from these collisions. Two international projects offer this opportunity, both located in Japan. The SuperKEKB collider will provide, from 2016, collisions at 10.6 GeV with the highest worldwide intensity, for the study of the B^0 - $\overline{B^0}$ system with an unprecedented precision. The other project, the International Linear Collider (ILC), targets high energy in the centre of mass, between 250 and 1000 GeV, and could start during the late 2020s.

In this framework, the proposed thesis subject addresses two major and complementary questions.
– Which sensitivity can the Belle II experiment at SuperKEKB reach on a new CP-violating phase and new physics?
– How much double-sided and pixelated detectors can help solving the challenging problematic of tracking in the inner part of experiments at e+e- colliders?

For the first part, the PhD student will perform an analysis of simulated Belle II data to evaluate the uncertainty on the determination of the sin2ß parameter. Specifically a detailed study will be conducted on the reconstruction, either inclusive or exclusive, of the so-called “tagging” B meson. These measurements, performed with processes involving quantum loops, impact our understanding of the CKM formalism and the matter anti-matter asymmetry, with a good sensitivity to processes beyond the Standard Model.

A key parameter for this analysis is the measurement quality of the z-position of each B meson decay vertex, obviously related to the inner tracker performances. In this perspective, the second part of the thesis will focus on a new concept of tracking elements made of double-sided layers of extremely thin CMOS pixel sensors. Such elements, produced by the PLUME collaboration, feature the unique ability to estimate the track direction with a single layer. The PhD student will exploit the PLUME layers for the commissioning of the SuperKEKB beams in 2016. The data collected will characterize these double-sided tracking layers for the first time in a collider environment. Such evaluation is of particular interest to the inner detector at the ILC.

[1] PICSEL group web pages: http://iphc.cnrs.fr/PICSEL.
[2] PLUME collaboration web page: http://iphc.cnrs.fr/PLUME.
[3] The Belle II Collaboration, STATUS AND PROSPECTS OF SUPERKEKB COLLIDER AND BELLE II EXPERIMENT, arXiv:1201.1248 (2012): http://arxiv.org/abs/1201.1248.