Measurement of the SuperKEKB induced background and preparation of the Belle II physics analysis.

Thesis supervisor: Isabelle RIPP-BAUDOT
IPHC, 23, RUE DU LOESS, 67037 STRASBOURG CEDEX 2
TEL: 03 88 10 63 75; E-MAIL: RIPP@IN2P3.FR

The Belle II experiment is currently completing the construction in Japan to start registering SuperKEKB collisions in fall 2018. This circular e^+e^- collider is designed to reach the highest ever achieved instantaneous luminosity of 8×10^{35} cm^{-2} s^{-1} and to deliver 50 ab^{-1} of data by 2024. Such a dataset corresponds to 40 times more than presently available from the previous experiments. The Belle II physics program aims to discover quantum manifestations of physics beyond the standard model, through measurement of unprecedented precision in the flavour sector, with beauty and charm mesons, and tau leptons.

SuperKEKB exploits a completely new collision scheme, based on nano-beams. Such intense beams will produce a very high level of background particles. This background will overwhelm the collision products and may degrade experimental performances, by increasing the detector occupancy and the radiation level. A careful background study is therefore an essential step to allow a robust extrapolation towards very high instantaneous luminosities and thus ensure a safe detector operation. Such a background measurement will be performed during the Belle II commissioning, called BEAST (Beam Exorcism for A STable Belle II experiment), which will start with the SuperKEKB switch-on in January 2016.

A first part of the thesis will consist in the characterisation of the SuperKEKB induced background in the Belle II inner tracker volume, relying on the unique information provided by PLUME double-sided CMOS pixel detectors. The 2 measured hits can be associated, providing information about the background particle incidence and track. The student will develop an algorithm based on PLUME measurements, aiming to identify the different background sources. He/She will then participate to the BEAST phase devoted to the collision mode commissioning, scheduled from May 2017 to January 2018, to validate the background simulations with SuperKEKB data. The simulation validation will rely on a deep understanding of the generation and the simulation of the physics processes produced by SuperKEKB beams.

The second part of the thesis proposition deals with the preparation of the physics analysis. It consists in improving the meson decay vertex reconstruction, by working on the B and D vertex separations in case of an inclusive reconstruction. Such an improvement will benefit a wide part of the Belle II physics program. One analysis channel will be chosen as a benchmark to quantify the vertexing performances, and an analysis of the first Belle II data will be carried out.

This thesis offers a unique opportunity to participate to the switch-on of a particle collider experiment and to analyse its first data. The student will stay several weeks at KEK, to present his/her results to the Belle II international collaboration, and to participate to the data taking.