University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

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MSc (University of Victoria, 2013)
MASc (Université de Sherbrooke, 2011)
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"The Study and Shielding of Electromagnetic Radiation from SuperKEKB Electron and Positron Beam Interactions"

Department of Physics and Astronomy

Monday, April 29, 2019
10:00 A.M.
Clearihue Building
Room B017

Supervisory Committee:
Dr. J. Michael Roney, Department of Physics and Astronomy, University of Victoria (Supervisor)
Dr. Maxim Pospelov, Department of Physics and Astronomy, UVic (Member)
Dr. Colin Bradley, Department of Mechanical Engineering, UVic (Outside Member)

External Examiner:
Dr. Jeffrey Martin, Department of Physics, University of Winnipeg

Chair of Oral Examination:
Dr. Lincoln Shlensky, Department of English, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

This project contributes to the research and development studies towards successful commissioning of the SuperKEKB electron-positron collider. This accelerator and storage rings complex aims at delivering the high-luminosity collisions of beams of electrons and positrons needed for the Belle II experiment. Such beams produce parasitic radiation—called "machine-induced backgrounds", or simply "beam backgrounds"—that have detrimental effects on the experimental apparatus performance and durability. The Beast II effort is dedicated to measuring the beam backgrounds, and aims at testing the predictive power of the background models that were used in various phases of the Belle II design. A second objective is to ensure that the environment is safe for the detector prior to installing it around the beam lines.

A major component of beam backgrounds consist of electromagnetic radiation. This study focusses on measuring this radiation at the location of the Belle II electromagnetic calorimeter. The measurements were achieved by placing scintillator crystals at positions representative of the Belle II calorimeter crystals that are the closest to the beam lines, and comparing the data with predictions for different operating parameters of the accelerator.

Different phenomena related to machine backgrounds were observed: vacuum scrubbing, the electron-cloud effect, injection-related noise, beam-gas scattering and Touschek losses. Studies on the positron ring showed average background levels 13.5 ± 3.5 times larger than simulation, whereas that ratio reached $O(10^2 - 10^3)$ for the electron ring. In the latter, the large uncertainty on the pressure measurements and the gas constituents limit the predictive power of the measurements. Radiation shields were also designed, fabricated, delivered and installed in the detector to protect the electromagnetic calorimeter from radiation coming from the beam lines.