

Final Technical Report

High Energy Physics at Belle and Belle II

PI John Yelton, University of Florida

Dates covered 06/01/2015 to 03/31/2016

This report covers the rather short timescale of this particular funding. During that time the PI (John Yelton) worked on his plan for data analysis as detailed in the original proposal. In addition he hired a post-doctoral researcher, Dr. Igal Jaegle who worked both on data analysis, but mostly on the commissioning of the BEAST detector, a precursor to the complete Belle II detector.

Data Analysis

Much of the data analysis comprised the measurement of the widths and masses of 5 iso-doublet of charm-strange-baryons. My basic technique for charmed baryon analyses is to first concentrate on reconstructing as large a sample as possible of the ground-state particles. I reconstructed substantial samples of 10 different modes of Ξ_c^0 and 7 of Ξ_c^+ decays, whereas previous Belle analyses used 3 and 1 modes for the two particles, respectively. The analysis, in turn, required a considerable amount of work to reconstruct hyperons, in particular Σ^+ and Ξ^0 which have macroscopic decay paths but decay into neutral particles so that a decay vertex cannot be trivially found. The technique for the reconstruction of particles of this type, which I first wrote for CLEO in a similar environment, was unknown to Belle. However, my Belle code has now been passed on to others inside the collaboration who are investigating details of $\Lambda_c \rightarrow \Sigma^+ \pi^+ \pi^-$

During the time of the project, this analysis reached the point of being presented to the Belle collaboration as a whole. Since that time, it has been published, but the report on that will await the report on my new DOE project that replaced this one.

Dr. Jaegle acted as coordinator of the “Dark Sector Physics” analysis group for Belle. He was given this responsibility after performing the analysis searching for the dark photon (“A”) and dark Higgs (h') into a variety of different states. This analysis was inspired by models of a dark sector which include not only WIMPS but also new gauge fields and Higgs bosons which act as mediators between Standard Model particles and the Dark Sector particles. He coordinated the Belle effort in this area, which comprises six different analysis projects. He personally worked on two analyses: radiative production of dark photons with prompt decay, and light dark matter search

in the radiative process. Possible signals for the Lightest Dark Matter particles are a single photon and missing energy, where the photons can be reconstructed by their conversions in the detector.

Service for Belle

JY acted as an internal referee on three Belle analyses. Dr. Jaeglé is an analysis group coordinator as detailed above.

Service for Belle II

The commissioning detector (known as “BEAST II”) is an important part of commissioning of the SuperKEKB collider and the Belle II detector. The U.S. groups play the lead role in the design, construction, and operation of the BEAST II. Even at the luminosities of KEK and PEP-II, it was found to be critical to measure the particle and X-ray backgrounds near the interaction point. Such measurements are needed to provide real-time measurements of luminosity and background levels to the accelerator group, to ensure a sufficiently low radiation level at the site of the detector, and to tune the simulation of beam-related backgrounds. With the intense beams planned for SuperKEKB, this need is even more important to the entire project than it was in the early days of Belle, with the collaboration determined to learn from previous experiences to ensure a smooth turn-on of detector operations. Dr. Jaeglé was responsible for coordinating and overseeing the geometry and digitization of the commissioning detector’s components into the “basf2” software infrastructure. These include PIN diodes and micro-TPC, BGO from Taiwan, “CLAWS” (fast scintillators, from Germany), “FANGS” (TPCs, from Germany), “PLUMES” (X-ray detector from France), diamond sensors (Italy), CsI and He3-tubes (Canada).

The 8 months of funded project was sufficient to make a good contribution to the analysis and software of Belle II. It was always envisaged as just a start. A graduate student has now been recruited with a view to work on Belle II software development and Belle analysis. The three of us continue to work actively in all areas.