APPENDIX A

SuperKEKB and Belle II Detector

The SuperKEKB electrons positrons collider is an upgrade of the KEKB accelerator and designed to reach an instantaneous luminosity of forty times higher than the KEKB record luminosity. Its commissioning is planned for the year 2015. Expecting that it will reach its design performance in the year 2020, an integrated luminosity of 50 ab^{-1} will be collected until 2022.

The higher luminosity also leads to higher background levels. The effect of background source, like radiative Bhabha scattering, Touschek scattering, and beam-gas interactions, on the detector performance is assessed in detailed simulation studies. A further consequence of the design for a luminosity of 8×10^{35} $cm^{-2}s^{-1}$ is the reduction of the beam energy asymmetry from 3.6/8 GeV to 4/7 GeV and an enlargement of the crossing angle from 22 mrad to 83 mrad [1].

The ground-breaking ceremony at KEK on November 18, 2011, was the formal start of the SuperKEKB project. The first new the low energy positron beam line (LER) dipole magnets were installed in the tunnel on February 7, 2012. The construction of the new damping ring has started this year as well.

Because of the increased level of background, the Belle II detector has to cope with higher occupancy and radiation damage than the Belle detector. Furthermore the increased event rate puts high demands on trigger, data acquisition, and computing. To be able to operate at the conditions at the SuperKEKB collider, the components of the Belle detector are either upgraded or replaced by new ones. A detailed description of the detector can be found in Ref. [2].

The innermost part of the tracking system consists of two layers of silicon pixel sensors (PXD) based on the DEPFET technology. It is surrounded by four layers of double

69 sided silicon strip detectors (SVD). With the excellent spatial resolution of the PXD an impact parameter resolution in beam direction of around 20 μm can be achieved leading to an improved determination of the vertex position. The larger outer radius of the SVD compared to Belle gives an increase in efficiency of about 30% for the reconstruction of $K_s \rightarrow \pi^+\pi^-$ decays inside the SVD. A precise measurement of the momentum of charged tracks is provided by the central drift chamber (CDC).

Improvements in the momentum resolution and the particle identification via dE/dx compared to the Belle CDC are achieved by a larger outer radius. A smaller cell size in the inner part increases the background tolerance. New electronics reduces the dead time from about 1 μs to 200 ns. For the identification of charged hadrons, the time of flight detector at Belle is replaced by a time of propagation counter (TOP). The usage of timing information of internally reflected Cherekov light allows for a compact design of this particle identification device in the barrel part. The forward region is instrumented with new RICH detectors (ARICH) using aerogel layers with different refractive index to generate Cherekov rings with the same radius for each layer. A kaon identification efficiency of > 99% (96%) at a pion mis-identification rate of < 0:5% (1%) is expected for $B \rightarrow \rho\gamma$ events reconstructed in the TOP counter (4 GeV particles reconstructed in the ARICH).

While the CsI(Tl) crystals in the barrel part of the Belle electromagnetic calorimeter (ECL) will be reused for Belle II, the endcaps will be equipped with pure CsI crystals which are faster and more radiation tolerant. To improve the signal to background separation under the higher background conditions at SuperKEKB, the electronics will be upgraded to enable a wave form sampling. Muons and KL mesons are identified by resistive plate chambers in the outer part of the Belle detector (KLM). For Belle II the endcap regions and the inner layers of the barrel region will be upgraded with scintillator strips to cope with the higher background rates.

The detailed descriptions of the Super KEKB accelerator and the Belle II detector can be found in Ref [2].

APPENDIX B

Helium Ethane Gas

Although the mixture of Argon gas is famous for the wire chamber, the use of a low atomic number (Z) gas is also important for minimizing multiple coulomb scattering contributions to the momentum resolution. Since low Z gases have a smaller photo electric cross section than argon based gases, they have an additional advantage to reduce background hits caused by low energy photons from synchrotron radiation and spent particles [16].

To selected the appropriate gas for the Belle II CDC, several candidates have been studied, but none has been found that is better than the Belle gas mixture of 50% *He* - 50% C_2H_6. The mixture has a long radiation length ($\sim$ 640 m), and its drift velocity saturates at about 4 cm/µsec with approximately 2kV/cm electric field. This makes on XT-function less sensitive to applied HV and simplify the calibration. In spite of a low Z gas mixture, good dE/dx resolution is provided by the large ethane component. Figure B.1 shows the measured drift velocity of the 50% *He* - 50% C_2H_6 mixture [2].

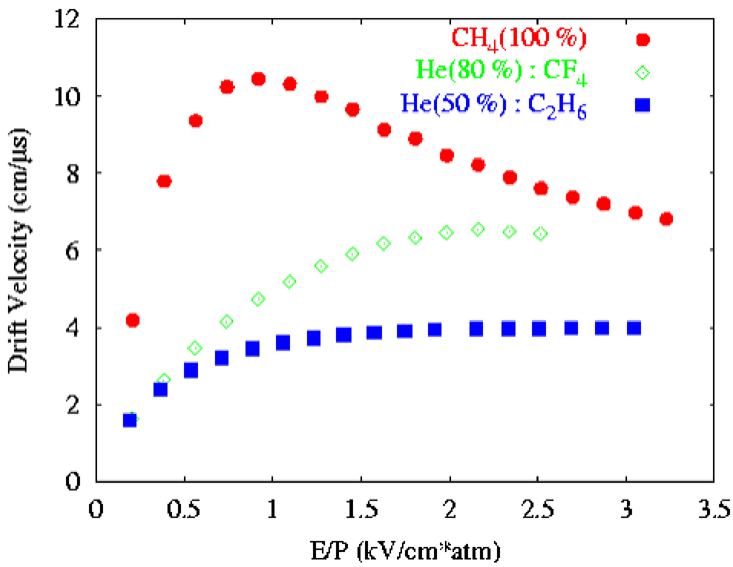

Figure B.1: the measured drift velocity of the 50% *He* - 50% C_2H_6 mixture.

APPENDIX C

Wire Replacement

The connection between the crimp pin and endplate is checked to find the mistake. A few of the wires are become loose or found as miss connection and they are replaced by new one.

(1) In the case of the sense wire, the wire is cut at the crimp pin and pull out.

(2) The aluminum field wire next to the sense wire is carefully pulled by 300 g weight. When a feedthrough is completely pulled out from the hole, fix the field wire at the endplate and cut wire at the feedthrough. Then new wire is connected with a pin.

(3) Pull out the field wire at the other side so that the field wire is replaced by a new long wire.

(4) Pick up the field wire by a hook from the hole of the pulled out sense wire and pull out the middle part of field wire.

(5) Connect the dummy wire to the pulled out part. The field wire should be kept the connection and pull the field wire connecting the dummy wire from the other side.

(6) Pick up the dummy wire from the hole of the pulled out sense wire. Isolate the dummy wire from endplate and check the insulation with the endplate and other wires.

(7) Replace the dummy wire with sense wire in the same procedure as (3)

(8) Put the feedthroughs and pins and crimp the both wires with the same way as wire stringing.

In the case of the field wire, procedure would be simple as (1)(2)(3).

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