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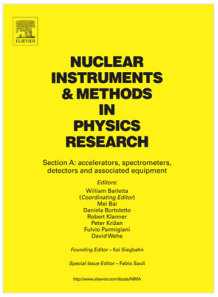

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SuperKEKB Collider

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Abstract

SuperKEKB, a 7 GeV electron – 4 GeV positron double-ring collider, is constructed by upgrading KEKB in order to seek new physics beyond the Standard Model. The design luminosity of SuperKEKB is $8 \times 10^{35}\mathrm{cm}^{-2}\mathrm{s}^{-1}$—40 times higher than that achieved by KEKB. The greater part of the gain comes from significantly decreasing the beam sizes at the interaction point based on the nanobeam collision scheme; the design beam currents in both rings are double those achieved in KEKB. Large-scale construction to upgrade both the collider rings and the injector was conducted, and beam commissioning without the Belle II detector and final-focus magnets was successfully carried out from February to June in 2016. Subsequently, renovation of the interaction region, including the installation of the final-focus magnets and Belle II, and construction in the final stage of a new positron damping ring are progressing. After these works are completed, beam collision tuning will start in early 2018. This paper reviews the design, construction, and beam commissioning of SuperKEKB.

Keywords: Electron, Positron, B factory, Asymmetric collider

1. Introduction

SuperKEKB is an asymmetric-energy electron–positron double-ring collider constructed by upgrading the KEKB B-Factory [1]. KEKB, which operated from 1998 until June 2010, achieved the world's highest luminosity ($2.11 \times 10^{34}\mathrm{cm}^{-2}\mathrm{s}^{-1}$); the total integrated luminosity accumulated by the Belle detector reached 1.04 ab^{-1} [2]. Using these data, the Belle collaboration succeeded in proving the Kobayashi–Maskawa theory and obtained a variety of important experimental results in elementary particle physics. Based on the success of KEKB, upgrading to SuperKEKB [3, 4], which significantly pushes the luminosity frontier toward more detailed experiments that seek new physics beyond the Standard Model, is considered an urgent issue in elementary particle physics. The design luminosity of SuperKEKB is $8 \times 10^{35}\mathrm{cm}^{-2}\mathrm{s}^{-1}$—40 times higher than that achieved by KEKB—and our goal is to accumulate an integrated luminosity of 50 ab^{-1}.

The SuperKEKB collider complex consists of a 7-GeV electron ring (the high-energy ring, HER), a 4-GeV positron ring (the low-energy ring, LER), and an injector linear accelerator (linac) with a 1.1-GeV positron damping ring (DR), as shown in Fig. 1. The extremely high luminosity of SuperKEKB required significant upgrades to the HER, LER, and final-focus system of KEKB. The injector linac also required significant upgrades for injection beams with high current and low emittance, as well as for improving simultaneous top-up injections. A new DR was designed and constructed for low-emittance positron beam injection.

Upon approval of the upgrade from KEKB to SuperKEKB, large-scale construction started in 2010. After 5.5 years of construction, beam commissioning of SuperKEKB started without the Belle II detector and final-focus superconducting magnets (Phase 1). Phase 1 commissioning was successfully carried out from February to June 2016. After Phase 1, the new final-focus superconducting magnets and the Belle II detector were installed at the interaction region (IR), and renovation of the IR and construction of the DR will be completed for the start of beam collision tuning (Phase 2), scheduled for early 2018. This paper reviews the design, construction, and beam commissioning of SuperKEKB.

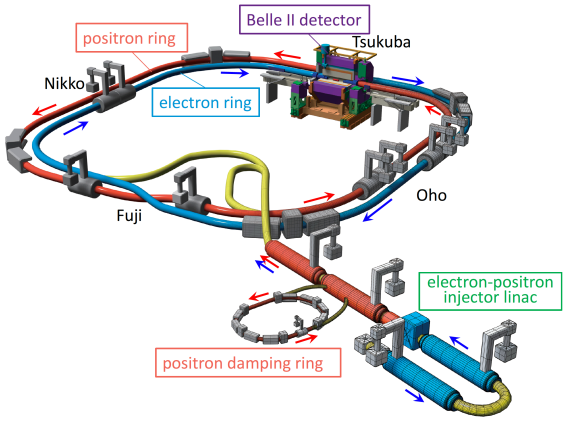

Figure 1: Schematic view of SuperKEKB. The electron and positron rings have four straight sections named Tsukuba, Oho, Fuji, and Nikko. The electron and positron beams collide at the interaction point in the Tsukuba straight section.

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