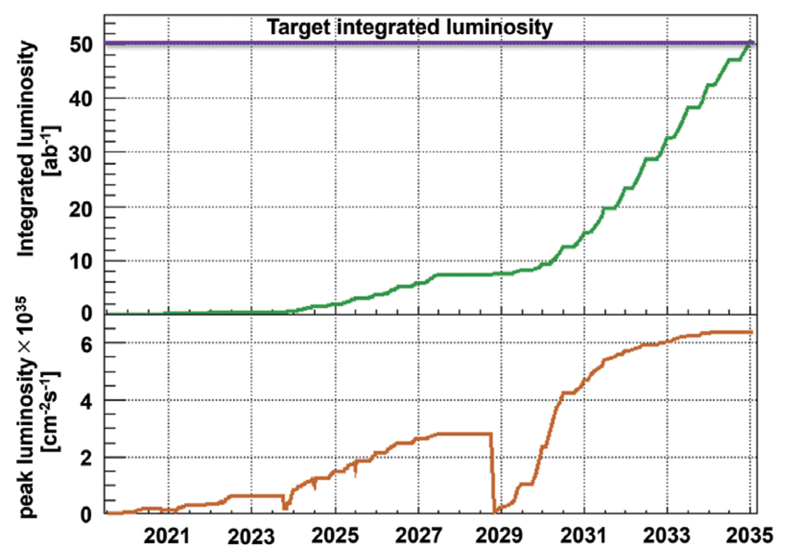
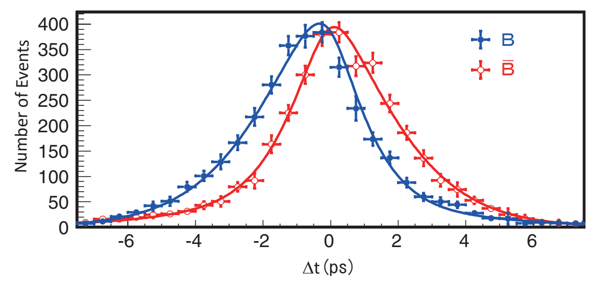
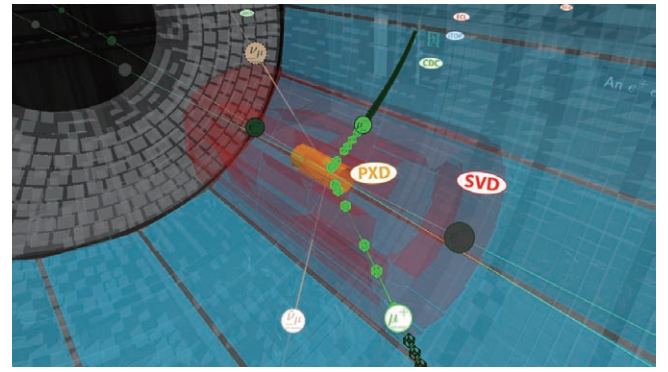


The SuperKEKB accelerator aims to deliver an integrated luminosity of 50 ab^{-1} by achieving a peak luminosity about 30 times higher than KEKB.





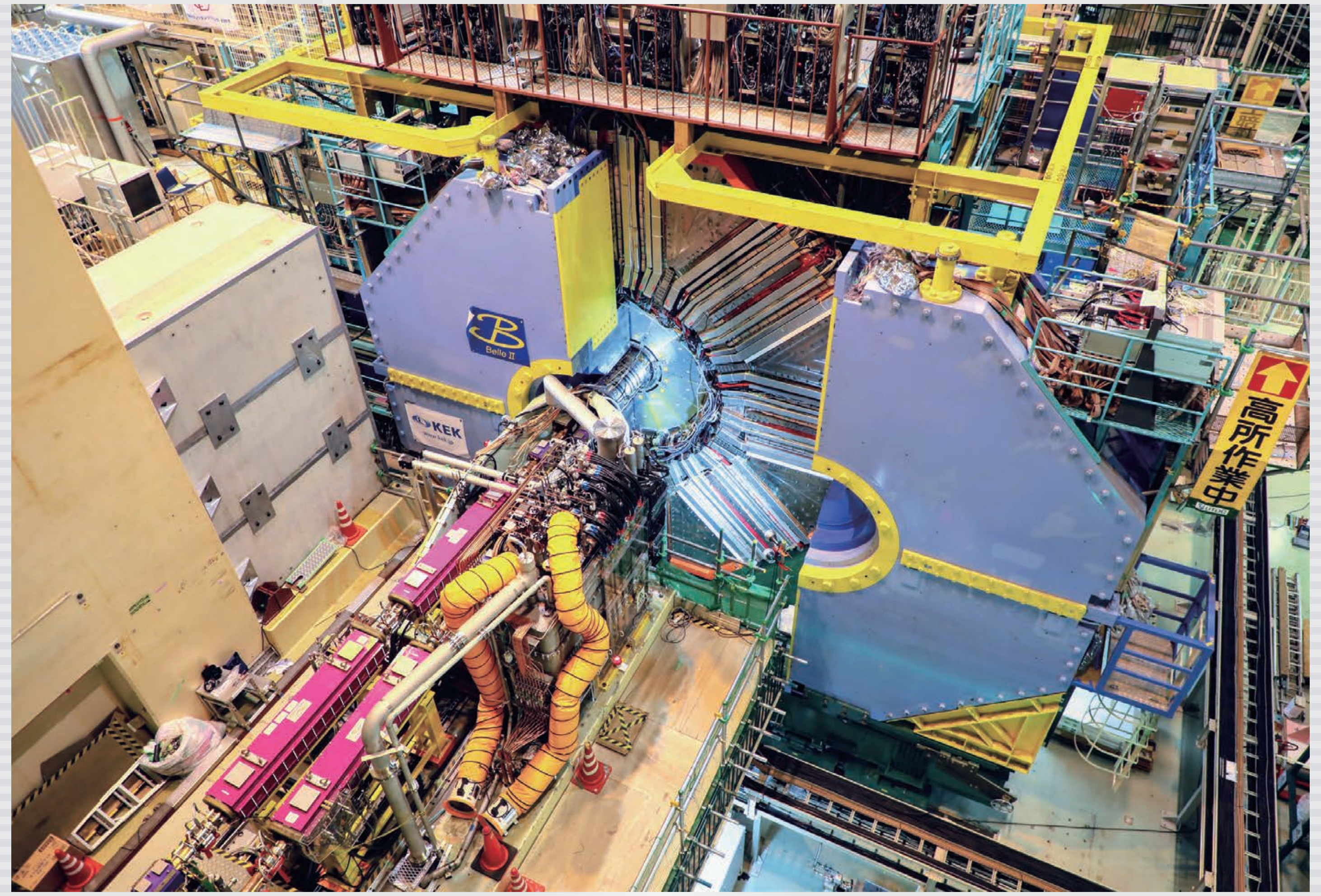
Visualization of simulated interactions of dark matter-related particles within the Belle II detector

Explore New Physics with SuperKEKB/Belle II

In 2001, the Belle experiment and the KEKB accelerator discovered CP violation in the decays of B mesons. CP violation refers to a difference between how matter and antimatter behave, and understanding this difference can help us explain how the early universe evolved to give rise to the matter dominated universe that we see around us today. Belle was able to find a difference between the decay times of B mesons and anti-B mesons when they decay into specific types of particles, such as J/ψ and K_S^0 particles. A theoretical mechanism for CP violation had been proposed in the 1960s, in what is now known as the Kobayashi-Maskawa Theory – the experimental evidence from Belle and KEKB confirmed this theory, and led to Prof. Kobayashi and Prof. Maskawa being awarded with a Nobel Prize for Physics in 2008.

However, the amount of CP violation as observed and explained by the Kobayashi-Maskawa Theory is far too small to explain the disappearance of the antimatter from the universe. Therefore there must be new physics, beyond the well established Standard Model of particle physics, that provides additional sources of CP violation. The SuperKEKB accelerator can produce a significantly higher number of B mesons than its predecessor, KEKB – with a goal of collecting a dataset 50 times larger. This will allow SuperKEKB and Belle's successor, Belle II, to play a leading role in the search for new physics beyond the standard model.

SuperKEKB

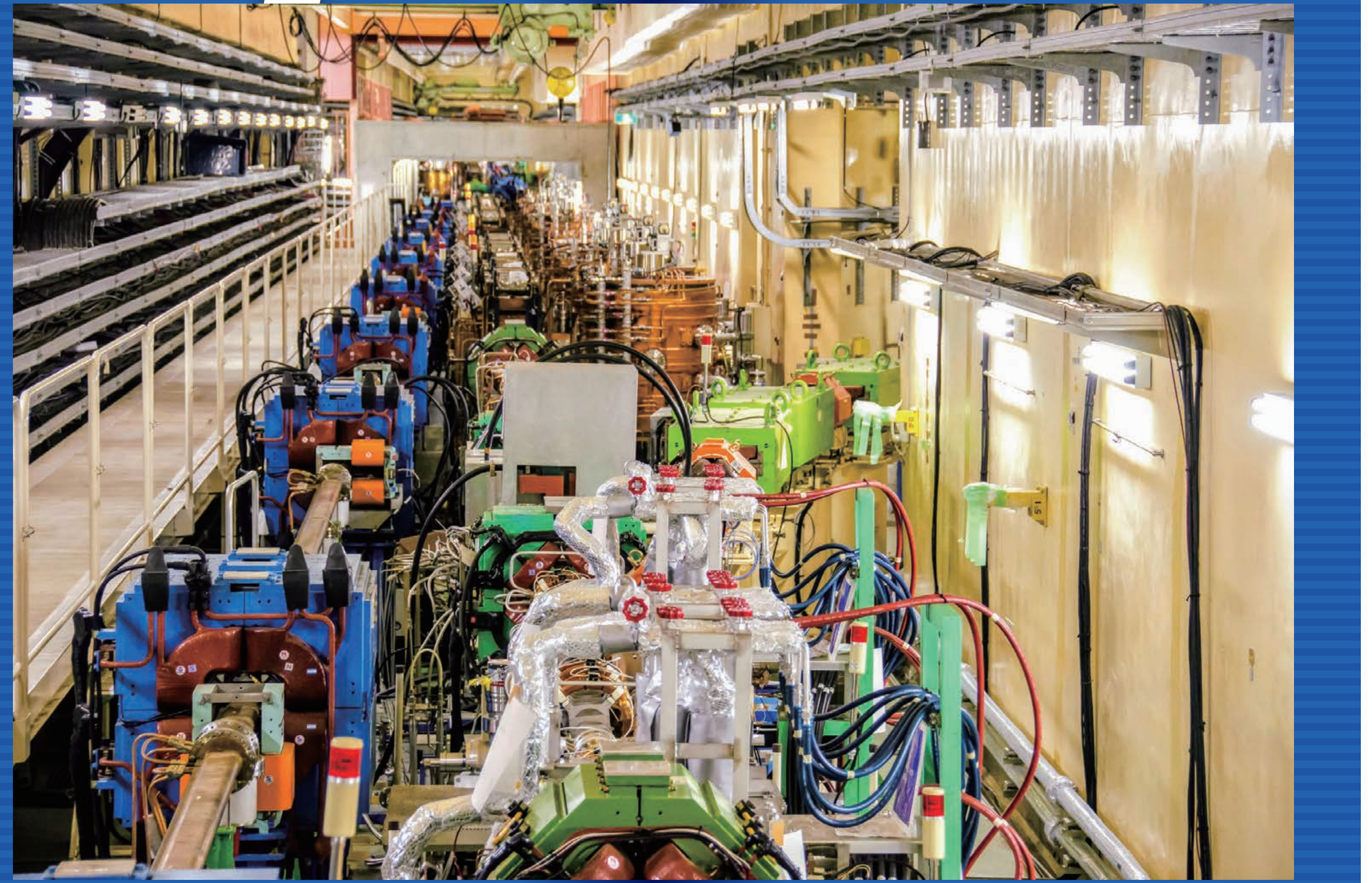


More **SuperKEKB** ▶
http://www-superkekb.kek.jp

High Energy Accelerator Research Organization / SuperKEKB Accelerator

2023.9

SuperKEKB



The SuperKEKB accelerator is an electron-positron collider that was built to aid us in our quest to unlock the many mysteries of elementary particle physics.

High Energy Accelerator Research Organization / SuperKEKB Accelerator

SuperKEKB

— The leading accelerator on the luminosity frontier —

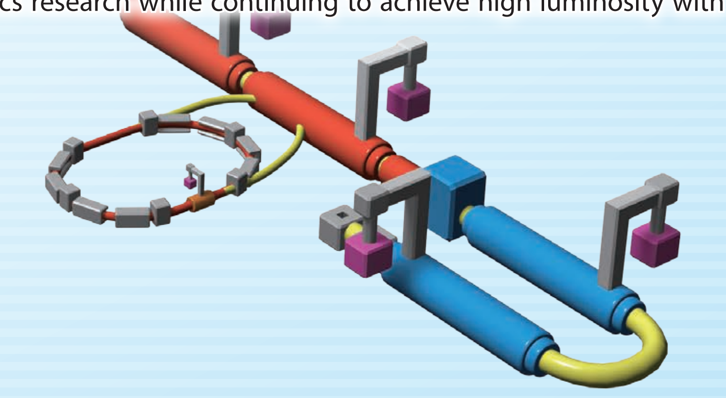
The SuperKEKB accelerator aims to allow us to discover new physics phenomena by studying the interactions of particles called B-mesons produced by the collisions of electrons and positrons (the antimatter counterpart of the electron, with a positive electrical charge).

One way to discover new physics phenomena is to use accelerators to reach higher and higher energies of particle collisions, but it is not the only way. Producing an extremely high number of particles, allowing for very precise measurements of their properties and decays allows the SuperKEKB accelerator to explore physics phenomena that cannot be investigated just by increasing the energy of particle collisions. This approach to discovering new physics is often called exploring the "luminosity frontier" and SuperKEKB, which will produce a number of B-meson and anti-B-meson pairs far exceeding the number produced by its predecessor, KEKB, will be at the forefront of the exploration of the luminosity frontier.

The SuperKEKB accelerator consists of two rings, an electron ring and a positron ring, together with an injector that supplies electrons and positrons to the rings. The two rings are located side-by-side in a tunnel with a circumference of approximately 3 km, situated about 11 meters underground. During operations, the electron beam (with an energy of 7 GeV) and the positron beam (4 GeV) are circulated in opposite directions around each ring at close to the speed of light. The two beams are designed to collide at only one point, called the interaction point - this is where the Belle II detector is installed to record interactions of the particles created by the collisions.

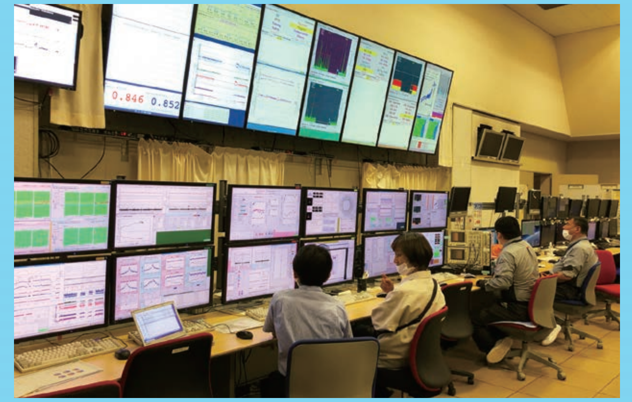
A quantity called luminosity is used to describe the performance of an accelerator, with a higher luminosity corresponding to a higher rate of particle collisions – to study rare physics phenomena an extremely high luminosity is required. The KEKB accelerator, the predecessor of SuperKEKB, achieved the world's highest luminosity at the time. From 2001 onward, the KEKB accelerator broke the world record for luminosity multiple times, eventually achieving a luminosity of more than twice its design value. The KEKB accelerator ended its operations in June 2010 and was upgraded to become the SuperKEKB accelerator, in order to achieve an even higher luminosity.

Many accelerator upgrades and improvements were made with a goal of increasing the luminosity by about 30 times compared with the KEKB accelerator; these included increasing the beam currents to 3.6 A (positron) and 2.6 A (electron), and reducing the dimensions of the particle beams to an extremely small size (about 10 μm in width and 50 – 60 nm in height), resulting in beams that are sometimes referred to as "nanobeams".
We will collect a very large dataset for physics research while continuing to achieve high luminosity with the SuperKEKB accelerator.



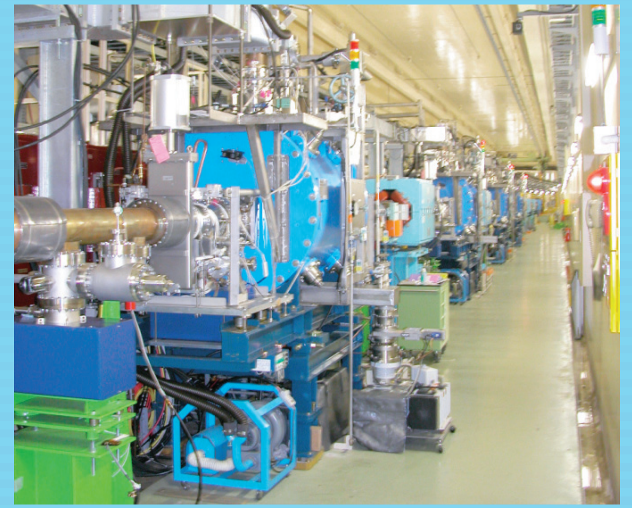
SuperKEKB

1 Central Control Room



Control hundreds of thousands of machine parameters in the central control room.

2 Superconducting Cavities

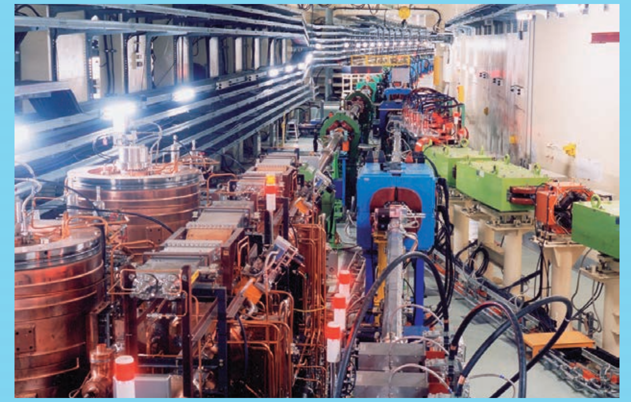


Aiming to accumulate a beam current of 2.6 A. Japan's world-leading superconducting acceleration technology.

3 Cryogenic Cooling System

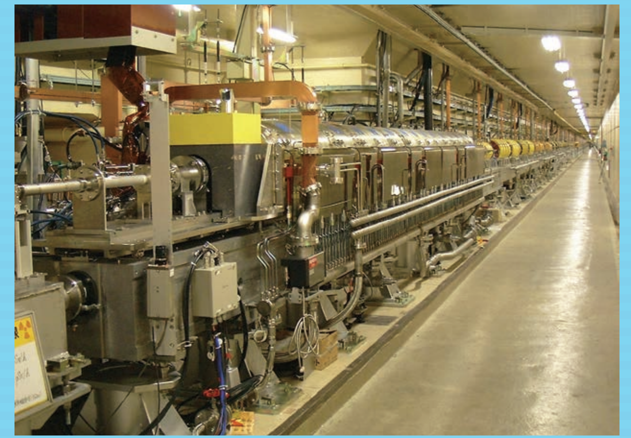
Helium gas is liquefied to cool the superconducting accelerating cavity to 4K by the helium liquefaction refrigeration system with low helium consumption.

4 Beam Transport Line



Transport electrons and positrons from LINAC to MR efficiently.

5 Linear Accelerator (electron-positron LINAC)



Provides electrons and positrons continuously to the MR.

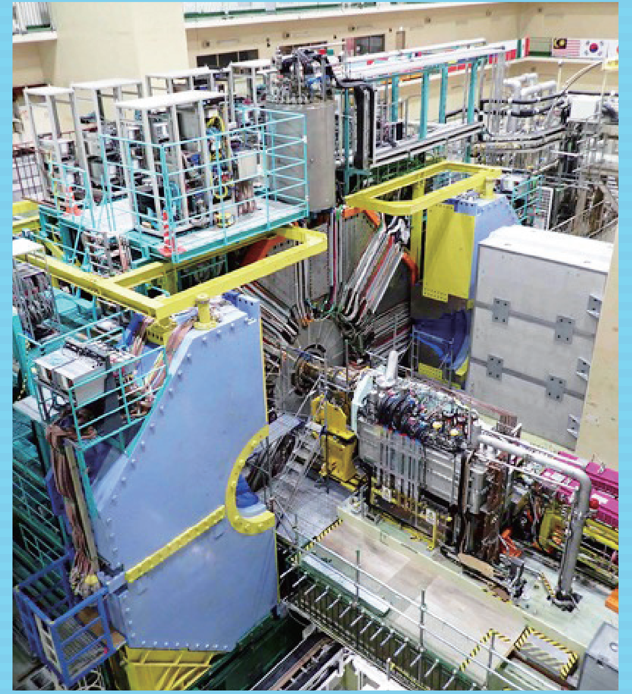
6 Klystrons

The world's highest output radio frequency power sources are installed in NIKKO, FUJI, OHO, and DR.

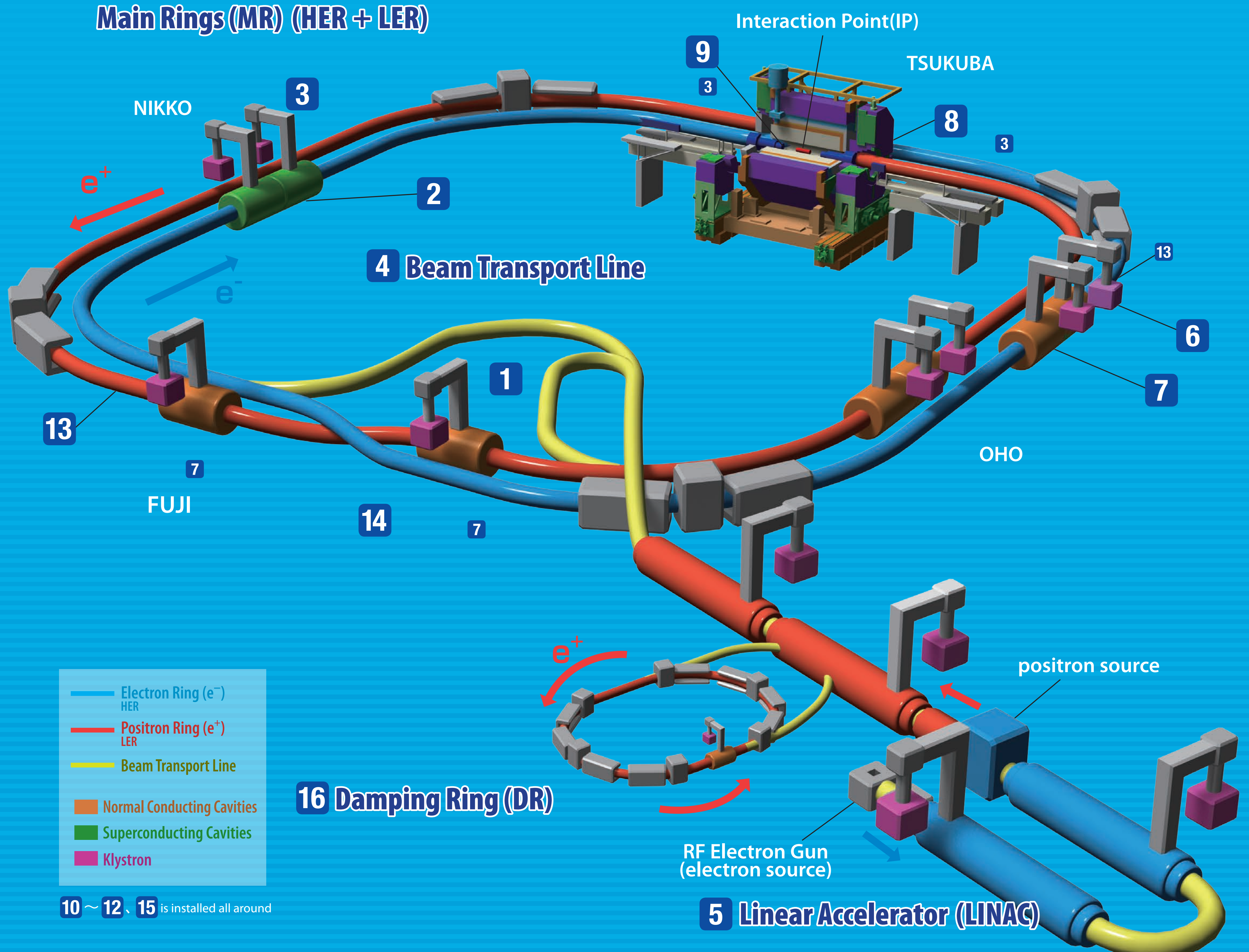
7 Normal Conducting Cavities (ARES Cavities)

Stable acceleration of large beam currents by the unique three-cavity system. (ARES: Accelerator Resonantly-coupled with Energy Storage)

8 Belle II Detector



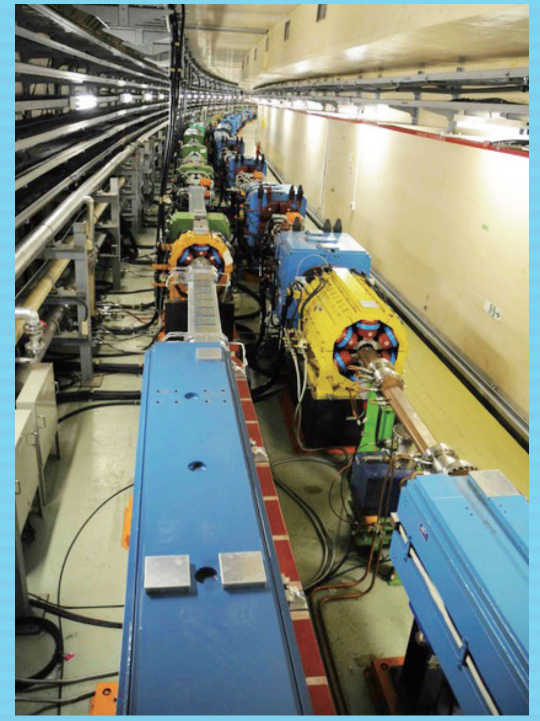
Investigate the decay of B mesons produced in the SuperKEKB accelerator and study elementary particle physics.



9 Final focus system

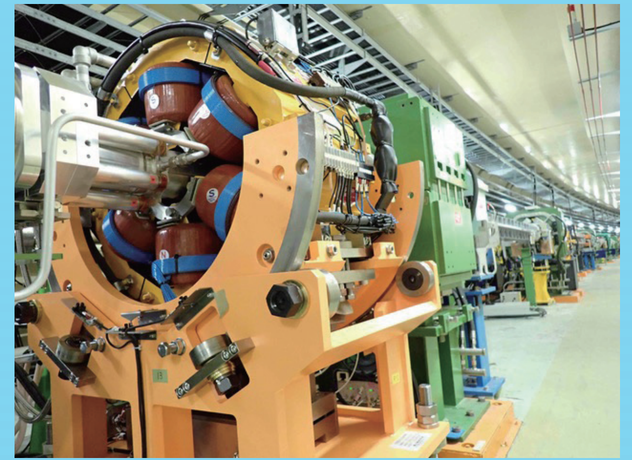
The final focus system consisting of superconducting magnets squeezes the beams at the interaction point.

10 Magnets



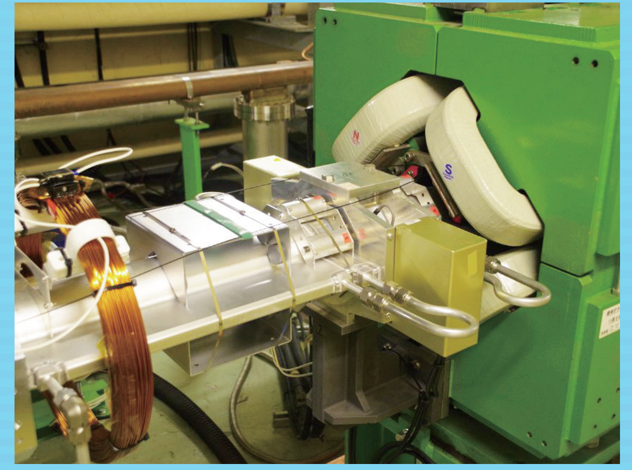
There are about 1000 quadrupole magnets, 220 dipole magnets, 200 sextupole magnets and 1100 corrector magnets installed in the MR to control the beams.

11 Sextupole Magnets with Variable Tilting Angles



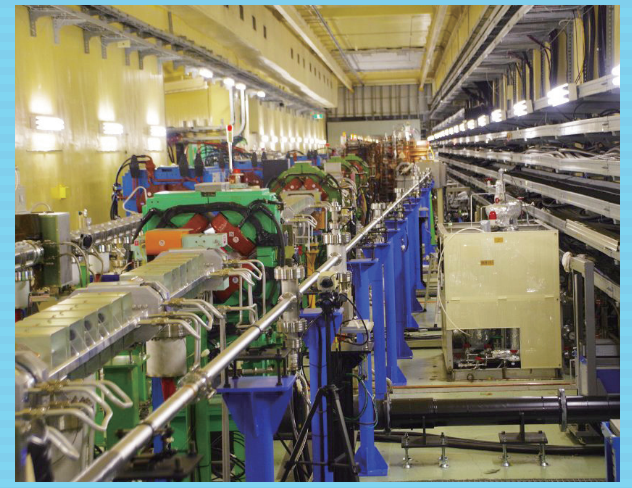
Those sextupole magnets with the tilting stage rotate ±30° around the beam axis to correct chromatic aberration.

12 Beam Position Monitors



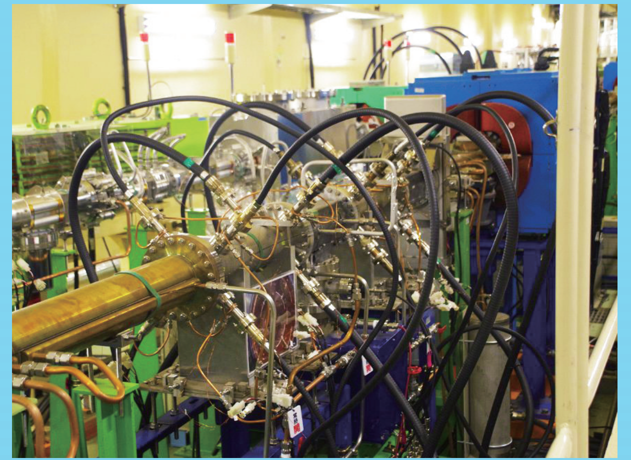
Beam position monitors that measure beam position with precision of better than 4 μm.

13 X-Ray Monitor



Monitors the vertical and horizontal beam size.

14 Bunch by Bunch Feedback

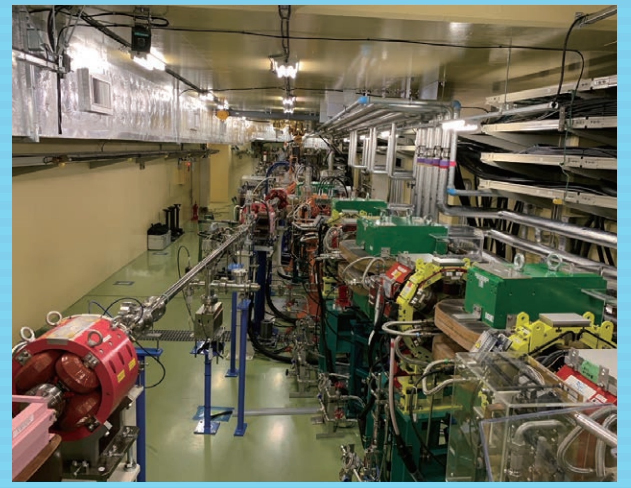


Suppresses beam instabilities.

15 Beam pipes

To keep high quality beams for a long time, the inside of the metal beam pipes where the beams pass through are evacuated down to ultra high vacuum region (~10^{-8} Pa).

16 Damping Ring (DR)



Decreases the dimensions of the positron beam to increase the efficiency of injection into the MR.