Sextupole Magnets with Variable Tilt Angles for SuperKEKB

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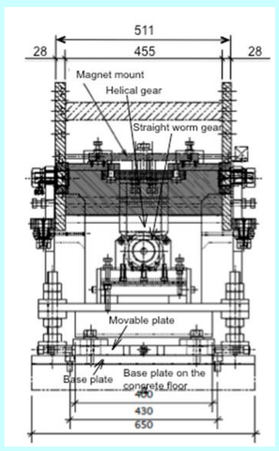
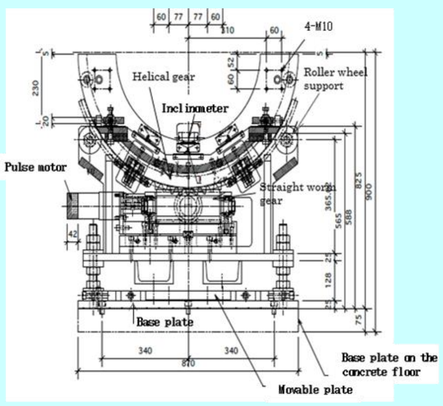
Introduction

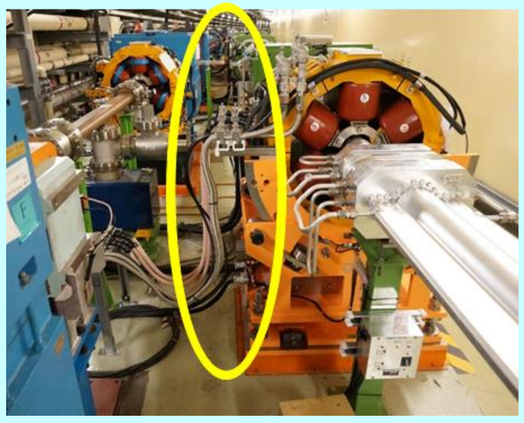
SuperKEKB is based on the "nanobeam scheme," a low-emittance lattice, where chromatic correction of the X-Y coupling at the IP is important. Skew sextupole magnets are found to be effective during KEKB operation. At SuperKEKB, the ratio of the skew to normal sextupole field component will be controlled by tilting the sextupole magnets. We fabricated newly tilting tables and sextupole magnets mounted on the tables to control the normal to skew sextupole field ratio. And the first commissioning of the tilting sextupole magnets was carried out. We report the details of fabrication and first commissioning of the tilting sextupole magnets.

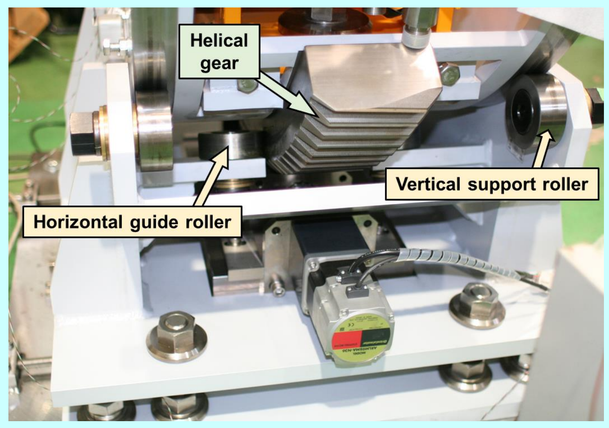




Fabrication of Tilting Sextupole Magnet

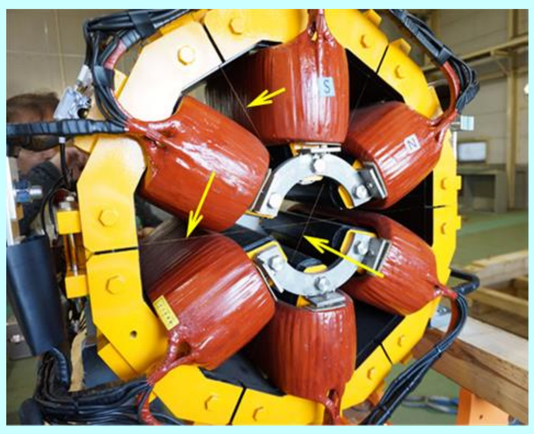
The sextupole magnets required modification, especially around the cooling water tube and electrical cable routing, to ensure that they fit in the small space between the HER and LER and the system can be tilted. The magnet tilted from −30° to 30° by a large helical gear under the top table for fixing sextupole magnet and straight gear. The tilting table and the side of the helical gear are supported and guided by four large roller wheels.





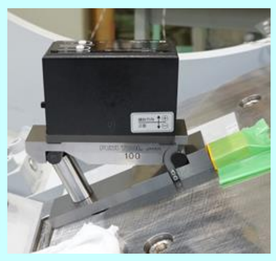
Adjustment of the Magnet Center

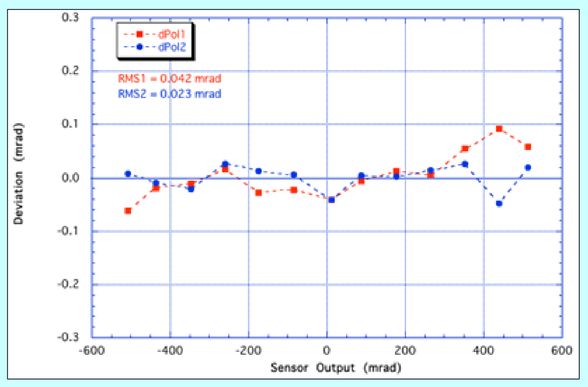
The magnet mechanical center was adjusted to the rotation center with crosshairs made at both ends of the magnet by three stretching thin beryllium-copper wires. We measured the horizontal and vertical positions of these crosshairs at +30, 0 and -30° rotation with a theodolite (E2, Leica). Using the displacement calculated from these measurements, the position of rotation center was adjusted with the adjusting bolts. This procedure was repeated until the displacement became less than 0.1 mm.

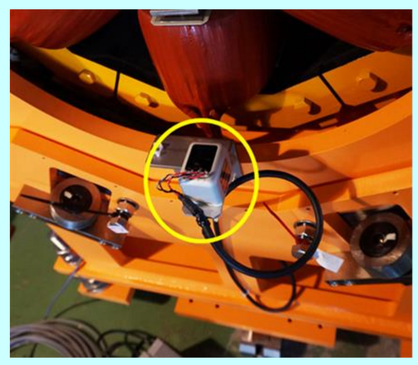


Calibration of Inclinometers

We calibrated the inclinometers by comparing the real tilt angle of the magnet and inclinometer's data. The real tilt was measured using Sine-bar tool and precision digital level. the calibration curve was constructed at fourth-order polynomials. The root mean squares of the deviations of the data in the two measurements for a tilting table were mostly less than 0.1 mrad in the calibration of all inclinometers.

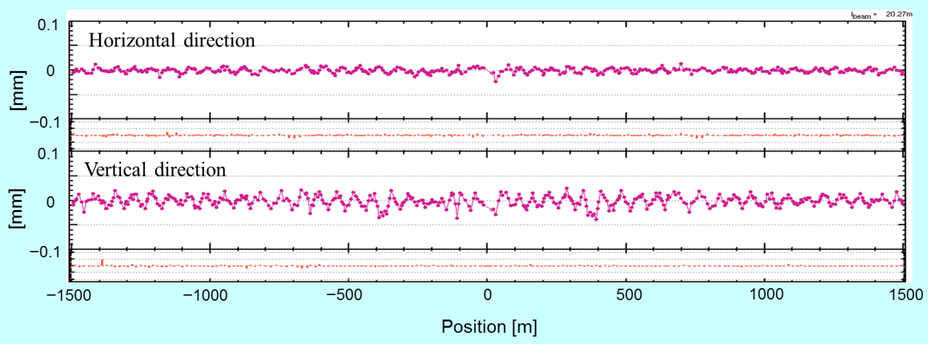


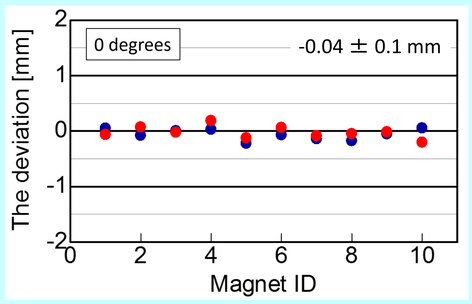


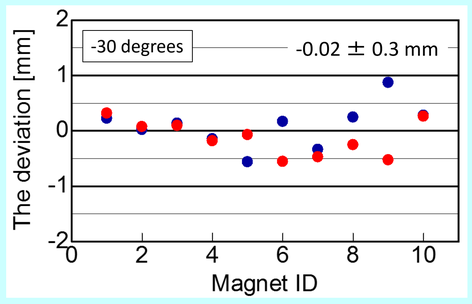


The Commissioning of Sextupole Magnets

As the result of the first beam test using the tilting sextupole magnets, the orbit distortion was found to be small and no beam abort was caused by tilting the magnets. The offsets of the magnetic center were found to less than 0.2 mm for most magnets at 0° with sigma of 0.1 mm. But the offsets increased at -30° with sigma of 0.3 mm.







Summary

We fabricated tilting Sextupole magnets for control the normal to skew sextupole field ratio.

- The magnet tilted from −30° to 30° using a large helical gear and straight gear.
- The mechanical center was adjusted to rotation center, the displacements were less than 0.1 mm.
- All inclinometers were calibrated until the root mean squares of the deviations became mostly less than 0.1 mrad.

We carried out the first beam test using the tilting sextupole magnets where;

- The orbit distortion was small and no beam abort was caused by tilting the magnets.
- The shift of the magnetic center was small for most magnets.

For Phase-II commissioning,

- The tilting table with a large shift in the magnetic center will be investigated.
- Remote control via EPICS is planned to be installed.