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Some experiences with the vacuum system in SuperKEKB

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The SuperKEKB, the upgrade project of KEKB, is an electron-positron collider with asymmetric energies, that is, 7 GeV electrons and 4 GeV positrons. The construction started in 2010 and ended in 2016. Following the test operation (Phase-1) and the commissioning operation (Phase-2), the physics operation (Phase-3) has started since 2019.
As for the vacuum system, most of the vacuum components, especially in the positron ring, were newly fabricated to especially manage the electron cloud effect (ECE), and to reduce beam impedance. Most of new beam pipes basically have two antechambers at both sides of a central beam channel. The main pump at arc sections of the ring is a strip-type NEG installed in one of the antechambers. New bellows chambers and gate valves have basically a comb-type RF-shield and have the same cross sections to the connecting beam pipes. Countermeasures against the ECE, such as the coating of TiN film, the grooved surface, the clearing electrode and so on, were adopted for the positron ring. The MO-type flanges, which have structurally little step inside, were adopted to the connection flanges between the beam pipes and the bellows chambers.
The physics operation has been continuing steadily gradually increasing the performance. The world-highest peak luminosity of 3.12E34 /cmˆ2/s has been achieved by June, 2021. Typical stored beam currents during the physics operation are approximately 800 mA and 700 mA for the positron and electron rings, respectively. The vacuum scrubbing of beam pipes is also processing steadily. The pressure rises per unit beam current are now approximately 1E-7 Pa/A and 2E-8 Pa/A for the positron and electron ring, respectively. The bellows chambers and gate valves with a comb-type RF-shield, and the MO-type flanges have been working almost as expected up to now, that is, no indication of discharge and over-heating has not been observed. The effect of antechambers and TiN coating on the suppression of ECE was confirmed, although additional external magnetic fields were required to suppress the ECE finally. One annoying problem was frequent beam losses accompanied by pressure bursts mainly observed in the positron ring during Phase-1, which were probably caused by collisions of the beam with dusts. Recently, very rapid (20˜30 micro second = 2-3 turns) beam losses have been observed sometimes accompanied with pressure bursts, but the cause has not been clarified yet and the investigation is ongoing. Here presented are the brief introduction of the vacuum system in SuperKEKB, and the major achievements and problems obtained in the beam operations so far.

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