INFN News

JAPAN: BELLE II OBSERVES THE FIRST COLLISIONS OF SUPERKEKB RUN 2

Operating at the KEK laboratory of Tsukuba, in Japan, the Belle II experiment is designed to study the properties of particles, especially B mesons, produced by collisions of electrons and positrons inside the SuperKEKB accelerator. It has just detected and registered the first events of its second data collection campaign, Run 2, which arrives after a year and a half of works dedicated to the upgrade and maintenance of the detector and of the accelerator. SuperKEKB started operating again last 29 January, and on 20 February Belle II actually recorded the first electron-positron collision. INFN participates in Belle II with a group of approximately 70 researchers from 8 facilities: the Frascati National Laboratories, and the Divisions of Naples, Padua, Perugia, Pisa, Roma Tre, Turin and Trieste.

The goal of Belle II is to measure, with extreme precision, the production mechanisms and decay of the particles produced by SuperKEKB in order to identify physical phenomena not predicted by the standard theory of elementary particles. These phenomena would throw new light on our understanding of the universe and the fundamental forces acting in it. The first data collection campaign, Run 1, took place between 2019 and 2022, providing the experiment with a sample of more than 400 million pairs formed by a B meson (charged or neutral) and its antiparticle. Numerous measurements of great interest to physics have already been obtained from this. Starting from summer 2022, in the so-called “long shutdown 1”, both the SuperKEKB accelerator and the Belle II detector underwent careful work to be optimised and updated. The goal was to enable the accelerator to reach higher and higher luminosities and for the experiment to reconstruct, with greater precision and efficiency, the events produced.

“The most important piece of work concerning Belle II was the installation of a new tracking detector in the innermost layer of the experiment, and, thus, the one closest to the interaction point between electrons and positrons. This is a silicon pixel detector that, together with the silicon strip detector (Silicon Vertex Detector - SVD) that surrounds it, makes it possible to measure, with very high precision, the point at which the charged particles pass”, explains **Giuliana Rizzo**, INFN researcher and professor at the University of Pisa, project leader of the Silicon Vertex Detector. “The work required the complete dismantling and reassembling the SVD detector, which was built and managed thanks to an important Italian contribution, also involved the installation of a new vacuum tube around the interaction point and the upgrade of the detector’s shielding from background radiation, more of which is produced by the accelerator as the luminosity increases. All these operations were successfully completed in the time frames established, making it possible to test the full functionality of the detector with cosmic rays and the recovery of the performance as it was prior to the work” Rizzo concludes.

SuperKEKB, in turn, underwent a series of improvements, at the end of which no problems were encountered in restarting operations. Both beams were injected and circulated with increasing currents for several days with the purpose of improving the vacuum inside the so-called beam pipe, or the pipe within which the particles circulate. Subsequently, researchers moved on to accurately adjusting the orbits that make it possible to collide the two beams of electrons and positrons. Finally, on 20 February, the conditions were stable enough to allow Belle II to switch on all its sub-detectors and directly observe a typical hadron event, i.e. composed of numerous particles coming from the interaction point, on its program for displaying detected particles.

The primary goal of this new data collection campaign, which has just started, is to record a greater quantity of data than that collected by the previous Belle experiment. With these data, and thanks to its greater performance and innovative analysis methods, Belle II will continue to make measurements of great scientific interest. Subsequently, the scientific group working on SuperKEKB intends to bring the machine up to the design performance, which will enable Belle II to collect a sample of data 50 times greater than that collected by Belle. Thanks to this, it will be possible to thoroughly investigate the presence of long-awaited, new physical phenomena.

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