The BEAST awakens at the SuperKEKB particle accelerator in Tsukuba, Japan

On February 10, 2016, one of the University of Hawai‘i at Mānoa’s physics projects, the Belle II experiment at the SuperKEKB particle accelerator in Japan, passed a critical technical milestone: SuperKEKB circulated a positron beam moving close to the speed of light through over a thousand magnets in a narrow tube around the 3.1 kilometre circumference of its underground main ring. On February 26, 2016, SuperKEKB succeeded in circulating and storing a 7 GeV electron beam around its ring of magnets in the opposite direction. The BEAST II accelerator background commissioning detector, designed by UH physicists, observed these first turns of the two beams and is now carrying out more detailed measurements.

The achievement of "first turns", which means storing the beam in the ring through many revolutions, is a major milestone for any particle accelerator. Since then, SuperKEKB has been making rapid progress, continuously increasing the positron and electron beam currents stored in the machine.

Once SuperKEKB is fully up and running, it will be collide electron and positron beams. In contrast to the Large Hadron Collider at CERN, which is the world's highest energy machine, SuperKEKB/Belle II is designed to have the world's highest rate of particle collisions (a factor of 40 higher than the earlier KEKB machine that holds many records for particle accelerator performance). Thus, SuperKEKB will be the leading accelerator on the "luminosity frontier".

This will allow SuperKEKB, along with the Belle II detector, to perform unprecedented searches for New Physics beyond the Standard Model by measuring rare decays of elementary particles such as beauty quarks, charm quarks and tau leptons.

Due to the high rate of collisions, the beams from SuperKEKB will produce an environment unlike any physics experiment in the past. The BEAST II detector will collect data in this environment, paving the way to allow Belle II to safely roll into the beam in 2017.

The Belle II detector at SuperKEKB was designed and built by an international collaboration of over 600 physicists from 23 countries. This collaboration is working closely with SuperKEKB accelerator experts to optimize the machine performance and backgrounds. The BEAST II detector measures beam backgrounds, produced by electromagnetic showers when the beam collides with the walls of the vacuum pipe. Such backgrounds not only obscure the signals that the team eventually wishes to observe, but also can radiation damage the Belle II detector. Therefore, when operating the new accelerator, these beam backgrounds must be well understood.

UH Mānoa Physics Professors Tom Browder, Sven Vahsen and Gary Varner, along with other UHM postdoctoral researchers and graduate students, participated in the first Belle experiment at Tsukuba, Japan’s KEK B Factory. It is celebrated for its critical role in experimentally verifying the theoretical scheme of Kobayashi and Maskawa, winners of the 2008 Nobel Prize in Physics.

Professor Browder is now the Belle II spokesperson, Varner is leading US readout electronics efforts, and Vahsen is leading the Belle II beam background group that designed the BEAST II
detector. UH Mānoa is responsible for major components of the Belle II particle identification readout systems using Varner’s renowned “oscilloscope on a chip” application specific integrated circuits (ASICs) as well as the background commissioning system, which detects neutrons with Vahsen’s innovative micro-time projection chambers (micro-TPCs).

In addition to the three UH Mānoa faculty members, members of the Belle II project are postdoctoral scholars Brian Kirby, Peter Lewis, Isar Mostafanezhad, Matt Barrett (now at Wayne State U.), Igal Jaegle (now at U. Florida), engineers Matt Andrew, Luca Macchiarulo, and Marc Rosen, and graduate students Shawn Dubey, Michael Hedges, Ilsoo Seong and Xiaowen Shi. Lewis, Jaegle, and Hedges are currently in Japan, operating the BEAST II detector.

Other collaborating institutes in the $15 million U.S. Belle II project include Carnegie-Mellon University, University of Cincinnati, Luther College, Kennesaw State, Indiana University, University of Pittsburgh, University of South Alabama, University of South Carolina, Virginia Polytechnic Institute, Wayne State University and Pacific Northwest National Lab.

The UHM Physics and Astronomy Department is located within the College of Natural Sciences. For more information on the research project, visit: http://belle2.kek.jp/

Photo Credit: K. Kanazawa of KEK
Photo Caption: The grey concrete bridge in the foreground shows the SuperKEKB particle accelerator interaction region, where electrons and positrons will collide in the future. This region is currently instrumented with the BEAST II commissioning detector. The large, coloured object in the background in the Belle II detector, which is scheduled to roll into the interaction region next year.