Data acquisition in phase II run of the Belle II Experiment

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Data acquisition in phase II run of the Belle II Experiment

➢ Belle II DAQ system
  ➢ Level 1 trigger could reach **30kHz** at the designed luminosity
  ➢ Common Readout system for different sub-detectors (Belle2link protocol, “COPPPER” readout board)
  ➢ Online data reduction
    ➢ High-level trigger
    ➢ ROI (Region of interest) on pixel sensors calculated by high-level trigger

Belle II beam runs just started!

People celebrated the 1st collisions on Apr. 26, 2018

➢ Phase II (2018 Feb-July): Data taking of beam collision data with the Belle II detector (Inner Pixel and Silicon vertex detectors were partially installed.)
High-rate commissioning with barrel calorimeter detector

Data acquisition of actual beam events

Event rate

- Data Acquisition with dummy trigger [Hz]
- Data Acquisition with "physics" trigger [Hz]

Event Display

Input: Constant 30kHz trigger

Efficiency = 99.2%
Data acquisition in phase II run of the Belle II Experiment

Belle II experiment and phase II run

- The Belle II experiment started in 2018 and is on the search for new physics beyond the Standard Model. The target luminosity of the SuperKEKB accelerator is 40 times larger than its forerunner experiments.
- Three phases for accelerator commissioning:
  - Phase I (2018): Accelerator commissioning and beam background study without the Belle II detector.
  - Phase II (2019-2021): Data taking of beam collision data with the Belle II detector (inner/outer and Silicon vertex detectors were partially installed).
  - Phase III (2021): Data taking with the full Belle II detector.

Belle II Data Acquisition System

- **Target trigger rate**: 20 kHz (up to 1 kHz in future)
- **Data flow** from many sub-detectors to PCIe/ESB
- **Data rate** from KLOE: 300 Gbps needs another dedicated DAQ system to reduce data size to ~1 GB/s

Partial high-rate test of the readout system

- Setup: 36 channels of ECL, and readout sub-system (CORPERS/real-time PC)
- Sunny triggering input to 36 ECL TEC boards
- The TECs send data to 7 DAQs (4 CORPERS + 3 real-time PCs) -> event database on RHEL6 (Intel server)

Data acquisition in phase II run

- First milestones in SuperKEKB were obtained by the Belle II detector on Apr. 30, 2018
- Currently, beam tuning is performed offline, and physics data are taken at night.
- Timing the machine timing, fake data test is performed with dummy trigger.

Data acquisition with Physic trigger

- Trigger rate and CPU usage
- With the current physics trigger, which requires CWC, track, and ECL, the current trigger rate is less than 30 kHz. Since the trigger rate is much lower than the designed 30 kHz, CPU usage on CORPERS and real-time PC is less than 1%.

DAQ commissioning with all sub-detectors

- Data acquisition with all Belle II sub-detectors was tested for the first time during the phase II run.
- The attained dummy trigger rate is around 50 kHz. For the target rate of 50 kHz, time is further needed for firmware on front-end electronics boards in some sub-detectors.
- The actual event size of each sub-detector in phase II data is compared with the predicted estimate for the Belle II DAQ design.
- They are currently not too different, while the event size could change as the real study is moved and beam background decreases in the future phase II run.