

# Data acquisition in phase II run of the Belle II Experiment

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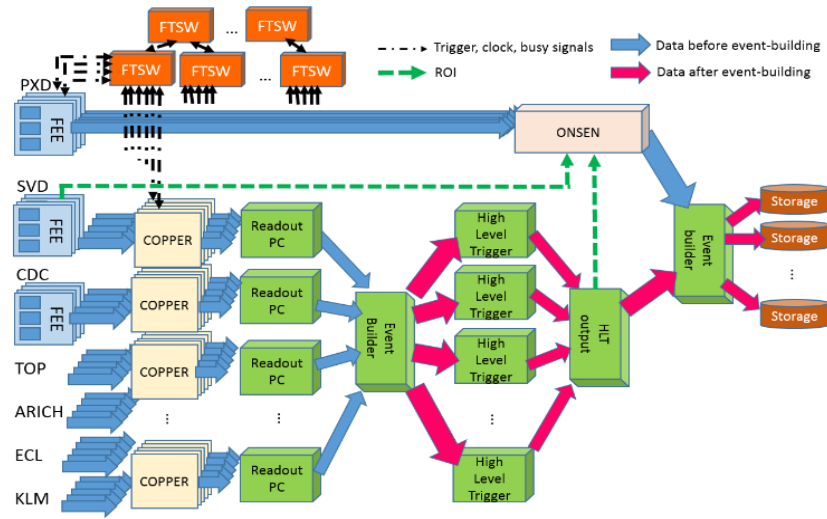
*2 Kitasato University, Sagamihara, Japan*

*3 Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, China.*



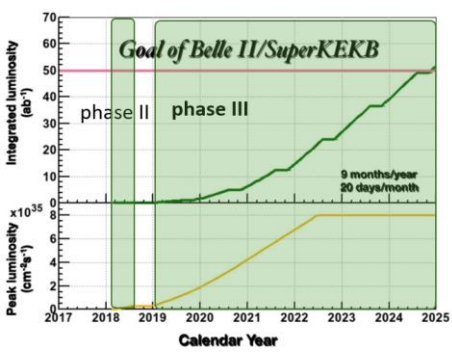
# Data acquisition in phase II run of the Belle II Experiment

## Belle II DAQ system

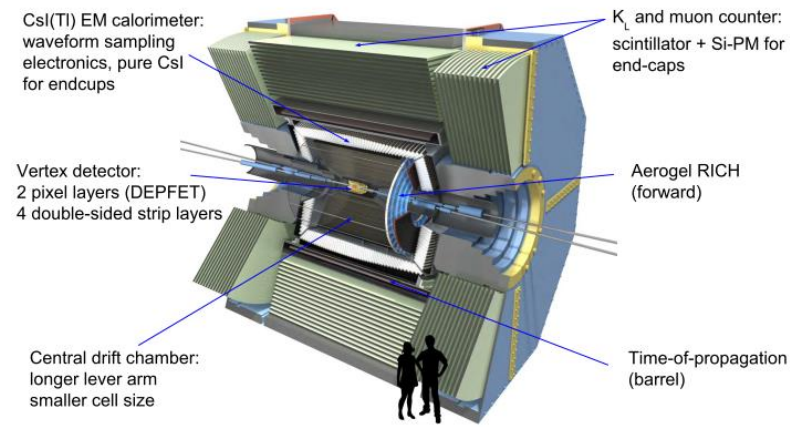


- Belle II DAQ system
  - Level 1 trigger could reach **30kHz** at the designed luminosity
  - **Common Readout system** for different sub-detectors ( Belle2link protocol, "COPPPER" readout board )
  - **Online data reduction**
    - High-level trigger
    - ROI ( Region of interest ) on pixel sensors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

## Belle II beam runs just started !

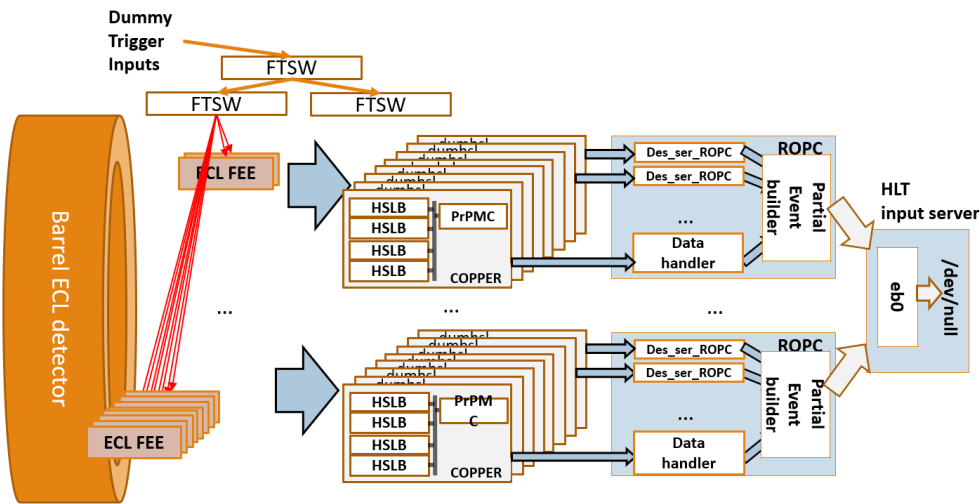


People celebrated the 1<sup>st</sup> collisions on Apr. 26, 2018

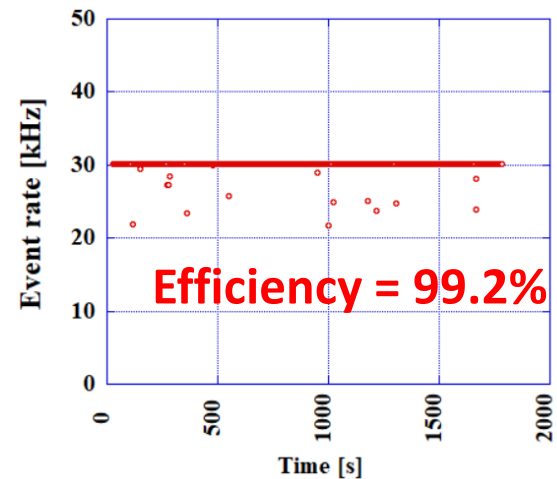


- **Phase II (2018 Feb-July)** : Data taking of beam collision data with the Belle II detector (Inner Pixel and Silicon vertex detectors were partially installed. )

## High-rate commissioning with barrel calorimeter detector

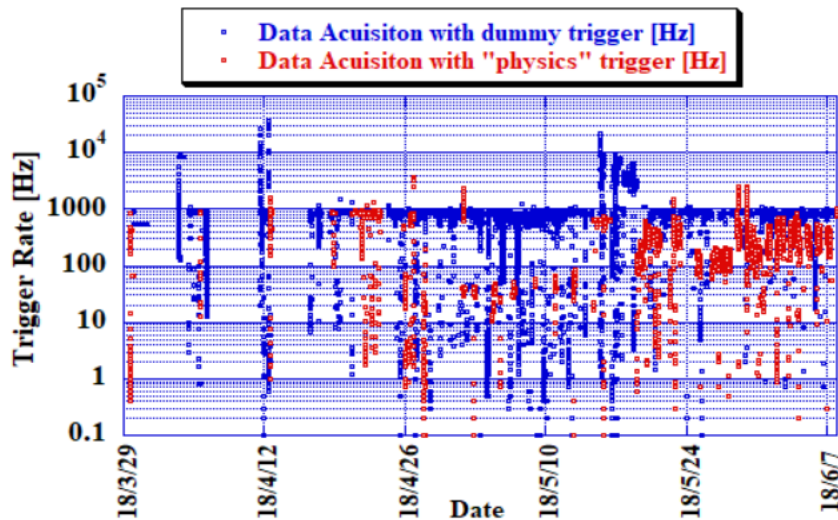


Input : Constant 30kHz trigger

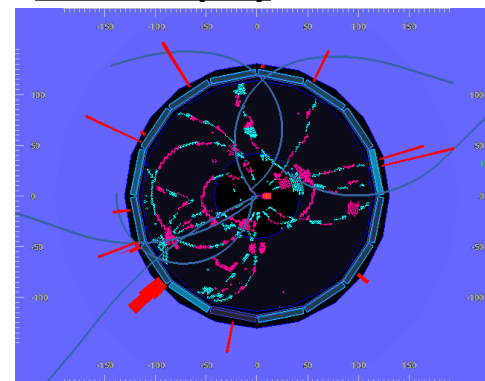


## Data acquisition of actual beam events

### Event rate



### Event Display





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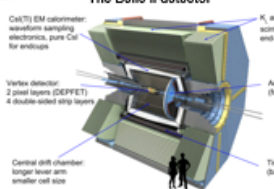
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## Belle II experiment and phase II run

The Belle II experiment has started in 2018 and focus on the search for new physics beyond the Standard Model. The target luminosity of the SuperKEKB accelerator is 40 times larger than in the former Belle experiment.

- There are three phases for Accelerator commissioning
- > Phase I (2016): Accelerator commissioning and beam background study without the Belle II detector
- > 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.)
- > Phase III (2019): Data taking with the full Belle II detector.

### The Belle II detector



### Luminosity Prospect of SuperKEKB



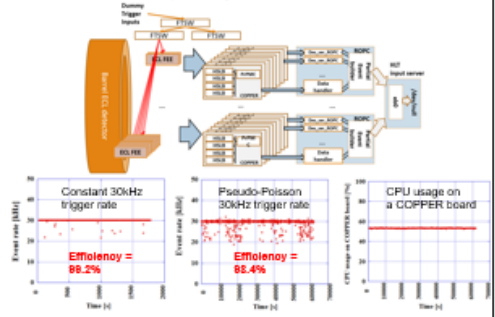
## Belle II Data Acquisition system

- > Target trigger rate : 30kHz (→ 500Hz@Belle)
- > Data flow from sub detectors except for FXD : 2GB/s
- > Data flow from FXD : 30GB/s (needs another dedicated DAQ system to reduce data size to 1GB/s)



## Partial high-rate test of the readout system

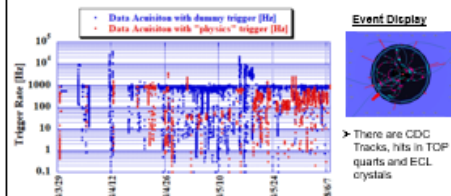
- > Setup : the barrel part of ECL and readout subsystem (COPPER/readout PCs)
- > Dummy trigger input to 36 ECL FEE boards →
- > The FEEs send data to the back-end DAQ (18 COPPERs → 7 readout PCs → event builder on HLT input server)



→ High efficiency (nearly 100%) was achieved.

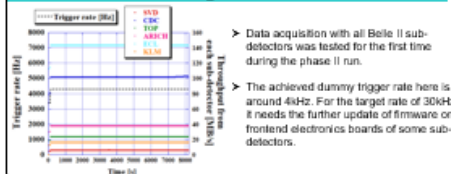
## Data acquisition in phase II run

- > First collisions in SuperKEKB were observed by the Belle II detector on Apr. 26, 2018
- > Currently, beam tuning is performed daytime and physics data are taken at night.
- > During the machine tuning, DAQ test is performed with dummy trigger.



There are CDC Tracks, hits in TOP quarts and ECL crystals

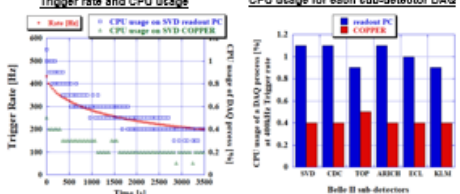
## DAQ commissioning with all sub-detectors



- > Data acquisition with all Belle II sub-detectors was tested for the first time during the phase II run.
- > The achieved dummy trigger rate here is around 4kHz. For the target rate of 30kHz, it needs the further update of firmware on frontend electronics boards of some sub-detectors.

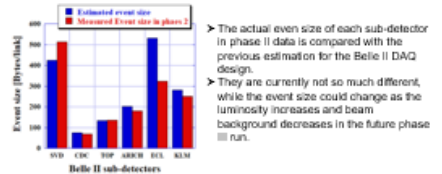
## Data acquisition with Physic trigger

### Trigger rate and CPU usage



- > With the current physics trigger, which requires CDC track and ECL hit, the current trigger rate is less than 500Hz. Since the trigger rate is much lower than the designed 30 kHz now, CPU usage on COPPER and readout PC is less than 1%.

### Event size of each sub-detector data



- > The actual event size of each sub-detector in phase II data is compared with the previous estimation for the Belle II DAQ design.
- > They are currently not so much different, while the event size could change as the luminosity increases and beam background decreases in the future phase III run.

