The Event Timing Finder for the Central Drift Chamber Level-1 Trigger at the Belle II experiment

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**Belle II Experiment and Level-1 Trigger**

**SuperKEKB/Belle II experiment**

The SuperKEKB/Belle II experiment aims to increase the peak luminosity of KEKB by higher beam currents and nano-beam scheme to achieve an integrated luminosity of 50 fb⁻¹. The Belle II detector, which consists of several subdetector components, is required to acquire data efficiently under higher background environment.

**Belle II Level-1 Trigger (TRG)**

TRG consists of four subdetector triggers and adopts FPGA-based electronics and logics are continuously upgraded. Requirements to TRG (Excerpt)
- Almost 100% efficiency to interest physics events
- Latency < 4.4 μs
- Precision of event timing decision < 10 ns

Goal: new CDCTRG module for a timing resolution of 10 ns and higher efficiency for charged track events

**CDC Event Timing Finder Logic**

**Track Segment (TS)**

- fastest timing
- priority timing

**Track Segment Finding**

- Track Segment hits (TSID + fastest timing)
- max. 64 hit timing associated with 2D track

**2D Track Finding**

+ Binding TS to Tracks

**Median Calculation**

**For Event Timing Decision**

**CDCTRG Event Timing**

**L1 Event Timing Decision**

**Universal Trigger Board 4**

The Universal trigger board (UT) is a general-purpose FPGA board for TRG. In order to realize more complicated and better performance logic, we developed UT4 as an upgrade from the UT3, which have been used so far. The ETF logic is implemented in UT4 and other modules are being replaced with UT4 in sequence.

**Performance in e⁺e⁻ Collision**

**Time resolution**

ETF have achieved a time resolution of 10 ns in std. dev., which is about half resolution of existing CDCTRG. In the hadron event with a large number of tracks, a resolution of about 5 ns is achieved.

**3D track fitting**

An ETF event timing improves the vertex resolution of 3D track reconstruction using a Neural Network. This is expected to reduce the L1 TRG rate that is triggered by beam background tracks emitted out of interaction point.

**Summary**

- A new module for the CDC trigger is developed to improve the event timing resolution on TRG for charged tracks.
- The new logic that introduced the fastest timing and median calculation was implemented to improve the accuracy.
- It was confirmed that the time resolution and efficiency were improved as expected in a beam collision operation.