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## Waveform Feature Extraction in Belle II Time-of-Propagation (TOP) Detector

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The Time of Propagation (TOP) subdetector at the Belle II experiment requires a single photon timing resolution of below 100 picoseconds to identify the type of charged hadrons produced in  $e^+e^-$  collisions at SuperKEKB collider. Due to data bandwidth constraints only the amplitude and the timing information calculated from the digitized photon pulses are transmitted to the Belle II DAQ system.

The initial feature extraction method used software constant fraction discrimination (CFD) to extract the uncalibrated signal timing information in the processing system. An offline time-base calibration (TBC) is used to correct the photon hit time. The main downside of this method is degraded time resolution for small signal amplitudes, due of their poor Signal-to-Noise Ratio. Template fitting applied to the digitized, time-base calibrated signal has been proposed to fix this problem.

Various template fitting strategies using analytical and chi-squared algorithms, employing both polynomial and experimental-data generated templates, have been studied. These methods are computationally more intensive than the CFD method. To keep the processing time within the necessary limits imposed by the projected high trigger rate at the design luminosity of the SuperKEKB accelerator, implementation in programmable logic is also being studied. The TOP firmware allows the optimal feature extraction algorithm to be chosen dynamically, depending on the number of waveforms pending processing. These studies and their results are presented here in detail.

### Minioral

Yes

### IEEE Member

No

### Are you a student?

No

**Authors:** VARNER, Gary (University of Hawaii); KOHANI, Shahab (University of Hawaii at Manoa); NISHIMURA, Kurtis (University of Hawaii); WEBER, Tobias

**Presenter:** KOHANI, Shahab (University of Hawaii at Manoa)

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