The Belle II experiment at the SuperKEKB $e^+e^-$-collider in KEK, Japan does start physics data-taking from early of 2018 with primary physics goal that is to probe the New Physics effect using heavy quark and lepton weak decays. During trigger and DAQ operation upon beam collision, it is important that Belle II detector status have to be monitored in a process of data-taking against an unexpected situation. Slow control system, built in the Control System Studio (CSS) which is a GUI window design tool based on Eclipse, is one of monitoring systems in Belle II operation. Database and archiver servers are connected to slow control system. Experimental parameters are downloaded to Belle II main database server which is based on PostgreSQL. Real-time results are stored in archiver server which is based on EPICS(The Experimental Physics and Industrial Control System) archiver appliances and tomatoc which is open-source java servlet container. In this study, we report the development of slow control system for the Belle II electromagnetic calorimeter (ECL) trigger system.

### Super KEKB / Belle II & Hardware Trigger System

- KKEB / BELLE collected ~3 $ab^{-1}$, but not enough for the New Physics search.
- The SuperKEKB target instantaneous luminosity is 40x higher than KKEB.
- Anticipated beam background (BG) level in the initial stage of the run is extremely huge and higher than the KKEB.
- Robust and flexible trigger system is indispensable to operate BELLE II against such a BG environment.
- All of Belle II readout and trigger system have been upgraded.

### Anticipated beam background (BG) level in the initial stage of the run is extremely huge and higher than the KKEB.

- **Sub-Trigger System (Hardware Trigger System)**
  - ECLTRG(SLC) is not only for super fast readout but also all sub-trigger should be prepared. Currently, only ECLTRG provides such functions.
  - Trigger requirement:
    - TRG efficiency: ~ 100% for Y(4S)
    - Max. TRG rate: 30 ktrigs at $80 \times 10^{34}$ cm$^{-2}$ s$^{-1}$
    - Latency < 5 ps
    - Timing precision < 10 ns
    - Min. event separation: 200 ns
  - **Ready signals**
    - KLM trigger: Total Energy, Isolated Clusters, and Bhabha Counting
    - BPID trigger: Precise timing and hit topology information
    - ECL trigger: Two energy hits in Cluster and Bhabha Counting
    - KLM trigger:
      - Initial trigger: ECL
      - Second trigger: Bhabha
      - Third trigger: KLM
    - **Database using** PostgreSQL and “PostgreSQL” package.

### ECLTRG OPI
- Ready signals and initialization commands of not only ECLTRG but also all sub-trigger should be prepared. Currently, only ECLTRG provides such functions.
- **Conclusion**
  - 1st version of slow control for ECLTRG is prepared.
  - ECLTRG initialization, ready signal, version and readiness of each sub-system is included on user GUI.
  - Some ECLTRG parameters are automatically saved on Belle II main database server.
  - Several EPICS PVs are archived such as luminosity, averaged hit-rate.
  - ECLTRG archived PVs are also helpful to SUPERKEKB developing.

### Slow Control System of ECL Trigger

- **1. User module Part**
  - GUI monitoring module
  - ECL Trigger library included
  - **GUI monitoring module**
    - ECL Trigger library included
    - Passing or not passing of test is on GUI.
  - **ECLTRG OPI**
    - Ready signals and initialization commands of not only ECLTRG but also all sub-trigger should be prepared. Currently, only ECLTRG provides such functions.
  - **ECLTRG OPI**
    - ECLTRG system consists of FAM, TMM and ETM. This user module shows status of each sub-system such as version and readiness.

### 2. Archiver Part

- **Based on EPICS Archiver appliance and “Apache Tomcat”.
  - ECLTRG outputs are archived on main archiving server.
  - Discussion is required to decide which data should be archived.
  - Connection between Archiver and NIM through EPICS is well established.
  - By utilizing CSS data-browser, it is possible to extract data from archiving server and plot on real-time.

### 3. Database Part

- **Database using** PostgreSQL package.
  - Upload/download parameter from local server to Belle II main database server.
  - When each run starts, some of currently applied parameters on hardware such as firmware version[8], FAM energy threshold[624] and timing offset[624] are automatically saved on local machine, converted to appropriate format and downloaded to Belle II main database server.
  - Other parameters such as pedestal[624] and fitter[CC][303264] will be added.
  - Comparing parameters on A, B and C will be added. If all 3 have same value, return 1. Otherwise, 0. This output will be added ECLTRG ready signal.

### Conclusion

**Main Points**

- **Trigger requirement**
  - TRG efficiency: ~100% for Y(4S)
  - Max. TRG rate: 30 ktrigs at $80 \times 10^{34}$ cm$^{-2}$ s$^{-1}$
  - Latency < 5 ps
  - Timing precision < 10 ns
  - Min. event separation: 200 ns
- **Ready signals**
  - KLM trigger: Total Energy, Isolated Clusters, and Bhabha Counting
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**Graphs and Figures**

- Schematic of ECLTRG database part
- Track information
- Database using “PostgreSQL” package.
- Upload/download parameter from local server to Belle II main database server.
- When each run starts, some of currently applied parameters on hardware such as firmware version[8], FAM energy threshold[624] and timing offset[624] are automatically saved on local machine, converted to appropriate format and downloaded to Belle II main database server.
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- Comparing parameters on A, B and C will be added. If all 3 have same value, return 1. Otherwise, 0. This output will be added ECLTRG ready signal.

**Tables**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detector luminosity</td>
<td>2018/06/05 00:00:00 – 2018/06/05 06:50</td>
</tr>
<tr>
<td>Data flow</td>
<td>parallel high-speed serial</td>
</tr>
<tr>
<td>Logic</td>
<td>hard-coded FPGA firmware</td>
</tr>
<tr>
<td>Algorithm</td>
<td>20–30</td>
</tr>
</tbody>
</table>

**Acknowledgments**

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**References**