This paper introduces a new Crate Distribution and Trigger Processing Module (CDT) designed for the KOTO Experiment at J-PARC, Japan. The CDT Module will work in the existing KOTO-ADC crates. Each 6U VME crate includes 16 ADC Modules which require an 8ns sampling clock and two trigger pulses. This new Module receives these signals from the System Master and distributes them to the ADCs via CAT6 interconnects. In addition to this Fan-Out function, the new CDT Modules collect high-speed serial LVDS Data from the ADC modules, representing Cluster Bits of the Cesium Iodide Calorimeter elements from each ADC Channel. This new feature doesn't require new ADC hardware and the Cluster Data are recorded via the same CAT6 cables that are used for Fan-Out. All local Cluster Bits from the KOTO CsI Crates are gathered into one place, a Decision Making CDT (DM-CDT), where a system Cluster Map is generated. Communication between the Crate CDT and the DM-CDT is done via optical links at 2.5Gbps data rate. Cluster Numbers, calculated inside the DM-CDT, are sent to Master via a CAT6 cable. Currently in the KOTO Experiment, the Level-1 Trigger decision is made based on the Total Energy of the Calorimeter. The Cluster Numbers collected with the new CDT, will be used in combination to the Total Energy values for an enhanced Level-1 Trigger decision. The full design and final test results are presented.

ARCHITECTURE

The CDT Module was designed to work in the existing KOTO-ADC Crates. Each crate includes 16 ADC Modules, which require a clock and two trigger pulses: Level One Accept Trigger (L1A) and LIVE. The CDT Module receives these signals from the System Master and distributes them to the ADC Modules.

In addition to this Fan-Out Function, the CDT Modules located in the 16 KOTO CsI Crates collect serial LVDS Data from the ADC modules, representing Cluster Bits for each ADC Channel.

This new feature doesn't require new ADC hardware and the Cluster Data are recorded via the same CAT5 cables that are used for Fan-Out.

KOTO CLUSTER TRIGGER

Using the new CDT Module, a Cluster Map of the entire CsI Detector can be created for each L1A event. Before each L1A, Cluster Bits from CsI ADCs are collected by the crate's new CDT, via the existing CAT6 cables. Eventually, all Cluster Bits from the CsI Crates are gathered into one place, where the Cluster Map is generated, and Cluster Numbers are calculated and sent to Master. Based on these numbers, a final L1A decision is made inside Master.

These functionality modifications are made by changing firmware in the same PCBs. Figure 3 presents the Cluster Trigger structure in which the CsI CDTs are collecting the Cluster Bits, and the non-CsI CDTs are performing the above mentioned functions.

CONCLUSIONS

18 pieces CDT Module were installed at J-PARC and successfully tested with Beam.

This new module allows the counting of final state photon clusters within a few microseconds and opens up additional kaon decay channels to be studied.